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WM. IRELAN, JR., State Mineralogist.

ELEVENTH REPORT

OF THE

STATE MINERALOGIST,

(FIRST BIENNIAL,)

TWO YEARS ENDING SEPTEMBER 15, 1892.

SACRAMENTO:
STATE OFFICE, : : : A. J. JOHNSTON, SUPT. STATE PRINTING.
1893.

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EDITOR'S REPORT TO BOARD OF EXAMINERS.

SAN FRANCISCO, July 22, 1893.

To the State Board of Examiners:

GENTLEMEN: In accordance with your instructions of March 18, 1893, I have edited the manuscript of the Biennial Report of the State Mineralogist under the provisions of the Act approved March 11, 1893.

It will be remembered that when this manuscript was originally submitted, the Board of Examiners declined to publish it entire, and printed only the brief report of the Trustees of the State Mining Bureau and the introduction to the report by the State Mineralogist. This report also called forth from the Governor the following expression, printed in his message to the Legislature:

> I have carefully read the biennial reports of the various State officers and public institutions, with the exception of those of the State Mineralogist as originally prepared, the State Agricultural Society, the Railroad Commissioners, the Bureau of Labor Statistics, the State Board of Horticulture, and possibly one or two others, which are so voluminous that none but the unemployed and those directly interested and expecting to derive personal benefit from them can have time to read. While it is the duty of those who prepare these reports to inform the public fully in regard to the conduct of their institutions, very often too little time is devoted by their authors to condensing their statements. Intelligent people do not require arguments, but simply facts, from which they draw their own conclusions. The enormous cost of printing some of these volumes seems to have escaped attention in many cases; notably in the case of the State Mineralogist, the cost of printing which, as presented, would have been over [illegible]0,000. I have no doubt that this is a valuable contribution, but I believe that $2,000 worth of intelligent editorial work bestowed upon the manuscript would have saved four times that amount in the cost of printing, and the volume would have been of greater value to those interested. People will not read long, tedious reports, and if it were not for the condensed statements given out through the press the people of the State generally would have very little information in regard to our public institutions.

The Legislature then passed an Act, which was approved March 11, 1893, making an appropriation for editing the manuscript of the report of the State Mineralogist for the two years ending September 15, 1892. This Act is as follows:

AN ACT MAKING AN APPROPRIATION FOR EDITING THE MANUSCRIPT OF THE REPORT OF THE STATE MINERALOGIST FOR THE TWO YEARS ENDING SEPTEMBER 15, 1892.

The People of the State of California, represented in Senate and Assembly, do enact as follows:

SECTION 1. There is hereby appropriated out of any moneys in the State Treasury not otherwise appropriated, the sum of five hundred dollars, or so much thereof as may be necessary, the same to be expended under the supervision of the State Board of Examiners, to pay for editing the manuscript of the biennial report of the State Mineralogist, for the two years ending September fifteenth, eighteen hundred and ninety-two, said manuscript having been filed with the Governor on said date.

SEC. 2. This Act shall take effect immediately.

There were in all 2,307 pages of this manuscript, largely type-written. I have condensed all that relates to the counties of the State very materially, as in some instances I found much duplication of former reports. By comparing the reports previously published, with the man-

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script, the duplicated matter was eliminated. In other cases, where there was no duplication, there was still room for condensation, by leaving out the less important matter, in order to reduce the volume of the report. In editing this manuscript I have endeavored to retain only what will be of use to the practical miners of this State, so as to confine the report within reasonable dimensions, as suggested by the Governor in his message to the Legislature.

Several of the special articles prepared for this report can well be omitted altogether, since they do not relate directly to the mining interests of California, though they may be of scientific value. These, so far as I am able to judge, have been carefully prepared, and are doubtless valuable for publication through other channels. I do not recommend their omission because they may be unworthy of publication, but simply because, in my opinion, they are out of place in the report of the State Mineralogist, as not being of practical utility to the mining public. Among these are the following:

"Catalogue of California Fossils. Part II, Bibliography and References; Part III, Additions to the Tertiary and Quaternary Fossils; Part IV, Remarks on Fossils collected in Orange County by Dr. S. Bowers; Part V, Descriptions and Figures of New Cretaceous and Cret. B (or Eocene) Fossils of California, with Notes and Figures of Tertiary Species." By J. G. Cooper. This is partly a continuation of an article in the Mining Bureau report of 1888, and was omitted from the report of 1890, though prepared for that. There are 116 pages of manuscript. There are also six full-page plates, figuring sixty-seven species of Cretaceous and Tertiary fossil shells.

"Aboriginal Pipes of California," by Dr. Lorenzo Yates. Of this manuscript there are 35 pages, with five plates containing fifty-two engravings. This article is mainly interesting to the student of American history and ethnology. It gives the forms, uses, and history of the tobacco pipe among the native American races. It refers to and describes the pipes made by the aborigines of South and Central California; and there are many quotations from other authors describing the pipes of other Indian tribes. The ceremonial uses of pipes are also described; as also the methods of manufacture.

"Aboriginal Shell Money of California," by Lorenzo G. Yates. In this manuscript there are 57 pages and seven full-page plates, with seventy-nine cuts in all. The paper covers a description of the ancient media of exchange among the sea-coast tribes; different kinds of shells used; scientific names of shells used by the aborigines of this State; also beads; quotations from reports of Bureau of Ethnology; wampum, etc.

All three of these papers would be better adapted for publication by an academy of sciences or an ethnological society.

"Santa Rosa Island," by C. D. Voy; 48 pages of manuscript and five full-page plates. There is nothing in this which relates to mines or minerals. It refers to the discovery of the island, shape, climate, contour, points, anchorage (no harbor), volcanic material, bluffs and ridges, sand drifts, mountains, fossils, mammoth remains, topography, ethnology, zoölogy, and flora.

"San Miguel Island," by C. D. Voy; 34 pages and eleven full-page plates. There is nothing in this chapter about minerals or mines. It gives a history of discovery, geographical location and dimensions, harbors, shape of island, soil, shells, volcanic material, Quaternary fossils,

Pliocene fossils, surface of island, bluffs, ethnology of aboriginal population, shell heaps or kitchen middens, ancient stone implements, stone disks, zoölogy, flora, etc.

Both of these papers of Mr. Voy show research and would be useful for a geographical or ethnological society.

The lithographs for these papers mentioned have been made and printed.

An article by the late Henry De Groot on "Hydraulic Mining" covers 90 pages of manuscript and has numerous engravings. It covers practically the same ground as the article by John Hays Hammond on the "Auriferous Gravels of California," published in the report of the State Mineralogist for 1889.

One of the chapters written by Mr. Fairbanks, entitled "Notes on the Geology of Los Angeles, Ventura, Santa Barbara, San Luis Obispo, and Monterey Counties," covering 54 pages of type-written manuscript, I have omitted. The work done there was purely scientific in its nature, and no attempt had been made to connect it with the mining resources of the region. As the field would have to be again visited, in order to bring out the economic and industrial relations of the geology, the present State Mineralogist retains this manuscript and Mr. Fairbanks was put in the same field to complete his investigations.

An article to which your attention is directed is the excellent one by Mr. A. H. Ricketts, entitled "A Dissertation upon the Origin, Development, and Establishment of American Mining Law." This covers 110 type-written foolscap pages. It is a first-class article, and of practical use to miners everywhere. It does not, however, relate exclusively to California, but from the nature of the subject, is of application all over the United States. Should the appropriation for public printing warrant, this article should be published.

As to the condensation of the work of the Assistants in the Field, more or less has been done on most of the chapters. Much of the information gathered had already appeared in the reports of the Bureau. From the two chapters on Nevada and Sierra Counties, 311 pages of manuscript were taken out.

In Sierra County some of the same field had been covered by Mr. Preston and Mr. Wiltsee. In some other instances the Assistants had gone over the same ground; that is, two had visited the same region at different times and some of the work was duplicated, each having worked independently.

To give you an idea of the rest of the condensation, it may be stated that from Mr. Fairbanks' chapter on "Geology and Mineralogy of Shasta County," 24 pages were eliminated from the 90 pages, a reduction of about 5,600 words. From his chapter on "Geology and Mineralogy of Tehama, Lake, Colusa, and Napa Counties," from 73 pages 19 were taken out, a reduction of about 1,900 words. From his chapter on "Geology and Mineralogy of San Diego and Orange Counties," 13 pages were taken from 108. As previously stated, his chapter on Los Angeles, Ventura, etc., amounting to 56 pages, has been entirely left out, that more complete work may be done upon it. All this manuscript of Mr. Fairbanks was type-written and had been carefully prepared.

Mr. Watts did work in twenty-six counties, and from the total of 100,000 words 73,440 words were left, a reduction of about 26,560 words.

In the work in three counties by Mr. Storms, the manuscript was

reduced from 40,000 words to 26,000, a reduction of 14,000 words. Two thousand words were also taken from his manuscript, in the article on "Mine Timbering."

The manuscript of Mr. Preston was correspondingly condensed. It is proper to state that Messrs. Fairbanks, Watts, Storms, and Preston all cheerfully rendered me assistance with their respective manuscripts in the work of condensation. Messrs. Wiltsee and Hobson were out of the State.

There are several minor chapters which may be omitted without great detriment. These are the North Fork District of Fresno County, the chapter on San Benito County, and that on Salton Lake.

It is to be regretted that in the case of some of the articles which are recommended to be omitted, the engravings belonging to them have all been made, but these were finished when the report was originally transmitted and there was no thought of cutting down its proportions.

It may be stated that the manuscript shows no signs of having been edited, aside from the mere paging of the leaves and arranging in order. A large amount of material had been left in which had already appeared in the last report or those of previous years. Where two assistants had worked in the same county at different times no attempt had been made to compare their reports and erase one of the duplicated portions. In some instances engravings had been made of the same thing to go in separate chapters written by different Assistants, and these engravings are ready for use. The Assistants, performing their individual work under general instructions, had written out their observations without knowing the details of the reports of others in the same field.

It is apparent that most of the manuscript had been recopied in the office from the original reports handed in by the authors. Part of this copying was evidently done by persons entirely unfamiliar with mining affairs, and the result was there were many absurd errors. These mistakes could not have been made by the original writers, for many were ridiculous in the extreme. This was not the case in all the copying, but in parts of it; there had been no revision after this copying.

No instructions had been given, apparently, for the Field Assistants to be concise in their reports. On the contrary, in many instances the work had been elaborated with the evident intention of making a very voluminous report. The system of tabulating the details of operation of individual mines immediately after each description, leads in every instance to useless repetition.

Sending two men to the same county or district and then not comparing the results of their work or their reports, leads to confusion and expense, for which the Assistants are not to be blamed. There has been little if any system in this regard, judging by the results as shown by this manuscript.

The original manuscript handed to me for revision consisted of 2,307 pages, largely type-written. The paging now reaches 1,144, from which must be deducted about 300 pages for erasures in the paged manuscript. None of the entirely erased pages are left in. This will make the report comprise about 844 pages of manuscript.

In this I have not included the article on "Mining Law," by Mr. Ricketts, which is 110 pages of foolscap, type-written. If the Board decides to publish this, then there will be 954 pages of manuscript.

The article on "Mine Timbering," by W. H. Storms, with nineteen

engravings, is a good one, carefully prepared. It deals, however, largely with Nevada and Dakota methods, adapted to more extensive operations than are general in this State, where there are few, if any, large chambers requiring the class of timbering mainly considered in this article. If considered too extended for this report, this article might be separately published at another time as a bulletin of the Mining Bureau, for the benefit of those who are interested in the subject.

The report as now submitted to you is almost exclusively confined to mining in the counties of California. Of course many of the engravings and lithographs which have been made will be useless. The engravings prepared for this report have been made at a great expense. There are now printed, ready for use, 10,000 copies of each of the maps and lithographs, yet comparatively few of them will be made use of by the State.

Very respectfully,

CHARLES G. YALE.

To his Excellency H. H. MARKHAM, *Governor of California:*

SIR: The Trustees of the State Mining Bureau herewith submit their report, in pursuance of the Act of the Legislature entitled "An Act supplementary to an Act entitled 'An Act to provide for the establishment and maintenance of a Mining Bureau,' approved April 16, 1880," approved March 21, 1885.

J. Z. DAVIS.
W. S. KEYES.
THOS. B. BISHOP.
W. S. LYLE.
W. S. WOOD.

SAN FRANCISCO, September, 1892.

REPORT OF TRUSTEES OF STATE MINING BUREAU.

The last Legislature of the State directed that the reports of the Mining Bureau be issued biennially instead of annually, as heretofore. Further, and as the Trustees respectfully suggest, in the exercise of a mistaken economy, the appropriation for the support of the Survey and Museum was reduced to the sum of $25,000 per annum. Of this amount three fifths was assigned for the work in the field, and two fifths for the exhibition rooms, the laboratory, and the working staff in the city of San Francisco.

The State Mineralogist has, owing to the smallness of the funds at his disposal, been obliged to greatly curtail the range of his investigations, but has, in our opinion, used due discretion in the selection of his expert assistants in the field of labor assigned to each of them. Full details of their work will be found in the report of the Mineralogist.

MUSEUM.

By the exercise of the very closest economy, Mr. H. S. Durden, the efficient Custodian of the Museum, has been enabled to keep within the appropriation, and not noticeably diminish the well-earned prestige of the State's exhibit of its precious and useful ores and minerals and its economically valuable oils, earths, waters, and building stones.

There have been catalogued up to date a grand total of 13,164 different specimens and groups of specimens. In this list is included 1,164 exhibits, which represent the additions since August 20, 1890. These consist mainly of ores, minerals, clays, and fossils, collected by the Field Assistants. Many of these fossils are new to science, and are now placed in the hands of competent specialists.

Donations to the Museum have been up to the usual average, but no large loan collection has been offered, nor in fact could any considerable loan exhibit be received, as the rooms are now so fully occupied that many interesting specimens are hidden from view in boxes, awaiting available space. Some room has been gained, so to speak, by altering and rearranging a portion of the shelving, and by returning to the owners certain loan collections of birds and curios, interesting enough of themselves, but not strictly in line with the purpose of a State economic and mining exhibit.

VISITORS TO THE MUSEUM.

The attendance at the rooms, as shown by the register, shows a gratifying increase. From October 1st, the date of the last report, up to the month of August, 1892, 77,605 different persons have registered their names, and of these 3,528 were pupils from the public schools of the city.

In view of the manifest popularity of the State's exhibit, the Trustees respectfully repeat that the usefulness of the Bureau would be enhanced were more commodious quarters obtainable through a somewhat increased appropriation.

LABORATORY.

Much useful work has been done in the laboratory, and much useful information has been gratuitously given to citizens in all parts of the State.

There have been received and answered 9,311 letters of inquiry, touching all manner of technical subjects, earth, ores, etc.; 2,814 specimens have been examined, and replies given either in person or by letter. Many of these answers have been the means of developing new enterprises, such as quarries, oil fields, borax and magnesite works, manganese, slates, etc.

LIBRARY.

Since October 1, 1890, there have been added to the library some 800 volumes and a large number of useful pamphlets. Most of these are the result of exchanges with kindred institutions at home and abroad. Lack of available funds has prevented much increase by purchase. The catalogue of the library is now complete, and will soon be in the hands of the printer.

FACILITIES FOR RECEIVING SPECIMENS.

The Trustees desire to repeat their sense of obligation to Wells, Fargo & Co., and to the Pacific Coast Steamship Company, for their kindness and public spirit in transporting, free of charge, all packages destined for the use of the Bureau up to twenty pounds in weight.

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STATE FAIR—COLUMBIAN EXPOSITION.

As permitted by the Act creating the Board, the Trustees, with the assistance of the Mineralogist and Custodian of the Museum, prepared an exhibit for the State Fair held at Sacramento in September of 1892. They are still further making ready for a large exhibit at the Columbian Fair to be held at Chicago, Illinois, in 1893. No effort will be spared to do credit to the State and to the Bureau.

We are greatly obliged to the editors and publishers of the following newspapers and periodicals which have been regularly received at the Bureau, free of charge, during the past year:

Calaveras Prospect, San Andreas, California.
Calaveras Citizen, San Andreas, California.
Central Californian, Fresno, California.
Daily Tidings, Grass Valley, California.
Daily Union, Grass Valley, California.
Downieville Messenger, Downieville, California.
Financial Mining Record, New York City.
Fresno Expositor, Fresno, California.
Humboldt Daily Standard, Eureka, California.
Inyo Independent, Independence, California.
Mining Exchange and Review, Denver, Colorado.
Middletown Independent, Middletown, California.
Mining Industry, Denver, Colorado.
Oakland Daily Tribune, Oakland, California.
Placer Argus, Auburn, California.
Placer Herald, Auburn, California.
San Leandro Reporter, San Leandro, California.
Santa Ynez Argus, Santa Ynez, California.
Siskiyou Telegram, Yreka, California.
Visalia Delta, Visalia, California.
Wallace Press, Wallace, Idaho.
Weekly Star, San Francisco, California.
West American Scientist, San Diego, California.
Wood River Times, Hailey, Idaho.

FINANCIAL ACCOUNT.

FROM OCTOBER 1, 1890, TO JULY 1, 1891.

Balance on hand October 1, 1890	$38,584 14	
Paid into Mining Bureau Fund	5,228 80	
		$43,812 94
Contra.		
Salary of State Mineralogist (9 months)	$2,250 00	
Salaries of geological assistants	10,750 20	
Traveling expenses of geological assistants	3,514 23	
Clerical assistance	855 65	
Freight and expressage	50 45	
Sundries, geological work	353 85	
Map account	7,122 15	
Rent of Bureau	2,250 00	
Salaries of Bureau employés	5,630 00	
Library	366 64	
Laboratory	147 42	
Freight and expressage	810 97	
Minerals and Museum	445 88	
Postage	681 82	
Sundries	954 72	
		$36,183 98
Balance		$7,628 96

FROM JULY 1, 1891, TO JULY 1, 1892.

Balance on hand July 1, 1891	$7,628 96	
Paid into Mining Bureau Fund	5,128 05	
Bureau appropriation, forty-third fiscal year	10,000 00	
Geological appropriation, forty-third fiscal year	15,000 00	
		$37,706 97

Contra.

Salary of State Mineralogist	$3,000 00	
Salaries of geological assistants	10,250 00	
Traveling expenses of geological assistants	4,583 75	
Clerical assistance	101 50	
Freight and expressage	6 68	
Sundries	144 50	
Rent of Bureau	3,000 00	
Salaries of Bureau employés	8,050 00	
Library	247 67	
Laboratory	148 39	
Freight and expressage	367 16	
Minerals and Museum	135 25	
Postage	105 75	
Sundries	638 06	
Clerical assistance	125 00	
		$30,903 71
Balance		$6,803 26

To his Excellency H. H. MARKHAM, *Governor of the State of California:*

SIR: In accordance with the provisions of an Act of the Legislature entitled "An Act to amend Sections 332, 333, and 334, and to repeal Section 335 of the Political Code of the State of California," approved March 12, 1872, relating to public reports, and in pursuance of the provisions of "An Act to provide for the establishment and maintenance of a State Mining Bureau," approved April 16, 1880, I herewith transmit my report.

WILLIAM IRELAN, JR.,
State Mineralogist.

SAN FRANCISCO, CAL., September 14, 1892.

REPORT OF THE STATE MINERALOGIST.

Nearly two years have elapsed since the publication of the Tenth Annual Report of the State Mineralogist, issued December 1, 1890. Up to that date the reports had been issued yearly. In accordance with an Act of the Legislature of 1891, "all officers, Boards of Officers, and Directors required by law to make reports to the Governor or Legislature, except the Controller of the State, must send the original drafts of such reports to the Governor before the fifteenth day of September, in the year eighteen hundred and ninety-two, and in every second year thereafter. The Controller of State must send his report to the Governor before the fifteenth day of December, in eighteen hundred and ninety-two, and in every second year thereafter." Therefore, until further legislative enactments the reports of the State Mineralogist will be issued biennially.

Within the past two years several changes of importance have taken place in mining affairs in the State of California. Among these the organization of a Miners' Association; the discovery of new mines, which promise to become remunerative; the active steps taken toward the resumption of hydraulic mining; the interest taken in the proposed construction of new lines of railroad, which will make easily accessible mining regions now too distant from railway transportation to make profitable operations possible. On the other hand, the unprecedented decline in the market value of silver has had a very unwholesome effect on the silver-mining industry, which was yearly assuming greater proportions, particularly in the southern part of the State. Yet, on the whole, the past two years have marked an era of progress in our mining affairs, and we may congratulate ourselves that the mining interests have advanced steadily, and give promise of increased output.

In almost every county in the State, new mining enterprises are in operation or are being organized. We have extensive quarries of marble and numerous other building stones, and investigations are now being made as to the feasibility of working into marketable products our practically inexhaustible economic deposits.

From statistics obtainable to date the output of gold will probably reach the sum of $13,000,000 during the year 1892. There will, however, be a serious falling off in silver production, owing to the fact that some of the largest producers have been obliged to suspend operations, being unable to work at a profit in consequence of the price of silver during the present year.

Looking over and carefully considering the metalliferous districts of California, the close observer is forced to the conclusion that these districts, as fields for active mining, disclose the fact that every important factor that goes to make mining an assured success has here strong representation. Considering, first, the variety and extent of our mineral resources, these are found to be very great. There occur in this State nearly every metal and mineral known to science. All that possess such economic value we certainly have. As these forms of our natural

wealth are not restricted to a few kinds, so are they not limited to locality. Besides our principal gold field, the largest of which man has any knowledge, we have here in California several others of minor extent, which would in most other countries be looked upon as of vital importance.

In nothing does the progress made in California quartz mining find more forcible illustration than in the low-grade ores we are now able to work with profit. Great advances have, it is true, been made in other departments of the business.

The great improvements in machinery used in hoisting, transporting, and milling are such that vast changes have been wrought in cheapening the expenses incident to mining.

Access to most of our mines is fairly good; railroads skirt the mountains in which the mines are situated, reaching in many instances the most important districts; while good wagon roads traverse nearly all parts of the mineral regions.

We work, at present, placer deposits, which were formerly passed by as worthless. It is even the case that these deposits have been worked over more than once—portions of them several times. While these various agencies have so helped to promote placer operations, they have told with special effect on the more difficult branch of quartz and other vein mining.

Where, at Grass Valley, the mines, in 1851, first began taking out quartz, only the richest portion of the ore was saved; all that failed to show gold with the aid of a glass being thrown on waste piles. Ore yielding less than $40 per ton would pay little more than the cost of mining and extraction.

Gradually the standard of workable ores has been coming down from that time until the present. We are now able to handle with profit gold-bearing quartz which returns a total under $2 per ton, this feat being actually accomplished at the Dalmatia Mine, near Kelsey, El Dorado County, where the cost of mining and milling amounts to only 43 cents per ton.

Nearly all of our mineral domain, excepting that portion which lies south and east of the Sierra Nevada, is well supplied with wood and water. The western slope of these mountains is covered with magnificent forests of fir, spruce, pine, and cedar, insuring here cheap fuel and lumber; most of the outlying districts are equally well timbered.

Down this slope of the great snowy range course no less than thirty-four rivers and streams, some of them carrying considerable volumes of water all summer. As these rivers pass through mining regions, making a great descent, their value as a means of generating a propulsive power can hardly be overestimated. Fully utilized, each one of these rivers would furnish power to drive more than ten thousand stamps. By retaining the surplus in reservoirs, for the construction of which there exist many eligible sites in these mountains, the water supply could be made to last the year round, and, owing to the elevation, could be delivered to the mines under almost any amount of pressure-head desired.

Already the work of transmitting the power generated by this fall of water to distant points through the agency of electricity has been entered upon in this State, the experiment made having proved eminently successful. That great benefits will grow out of this new use of the electric current may be expected, there being many mines upon which the introduction of water is not practicable, but to which the power pro-

duced by a water-driven wheel might be carried through the medium of an electric conductor.

That a new and more prosperous mining era awaits us is clearly apparent. With so many and such notable advantages for its successful prosecution it ought to see a marked advance at once. Our bullion is already on the increase, even more rapidly than it has been during the past few years.

HYDRAULIC MINING.

The question of hydraulic mining in the enjoined districts of California has, during the past two years, received much attention, and that from parties other than those more directly interested in its determination. The consideration of this question has, in fact, been greatly broadened, its importance having of late begun to impress itself deeply on the public mind, and while journals representing the anti-debris sentiment have abated something of their hostility to the miners, the metropolitan press has opened its columns more freely to a discussion of this issue than ever before.

Finding, after years of vexatious and costly litigation, that a satisfactory adjustment of this question could not be reached in the Courts, either State or Federal, the miners finally concluded to invoke legislative aid. In the furtherance of this purpose a delegation representing their cause was, during the past winter, sent to appear before Congress, in which body the entire subject was ably presented and by it patiently considered.

Assisted by the strong hand of the National Government, we can now see the end of this controversy, which has for so many years waged between the farmers and the miners, to the great detriment of both.

To say nothing of the increased prosperity which a resumption of hydraulic mining will bring with it, a cessation of the bitter feeling incident to this protracted strife will in itself be worth a great deal to California.

DRIFT MINING.

On account of the embargo placed upon hydraulic mining (and after many years of patient waiting), the miners in several places within the hydraulic confines have resorted to drift mining. Though more expensive than hydraulicking, and yielding less profit, this system is doing fairly well.

In some of the ancient river-bed regions hydraulicking would be impossible, on account of the lava cappings which cover the gold gravel deposits; therefore, these must necessarily be exploited by the drifting system.

RIVER-BED MINING.

The river-bed mining operations are carried on in California on a more extensive scale than in any other country, and the undertakings are more successful. In the northern counties, where this system of mining and river drainage is more prominent, a large number of Chinese are engaged, largely as owners of the properties, and are eminently prosperous.

On the several forks of the Yuba, Feather, and American Rivers there are a number of American companies and very many Chinese engaged

in mining the beds of these streams. These localities were about exhausted years ago, but have been reënriched from workings situated above. These operations are usually conducted by wingdams, or by diverting the entire stream by means of dams, ditches, or flumes.

VEIN MINING.

Although placer mining is one of California's great industries, and furnishes employment to thousands, vein mining is by far the superior industry in our mineral kingdom at present. It might be asserted that, since the cessation of hydraulic mining in the inhibited sections, fully two thirds of the gold recovery is from the auriferous quartz veins. Vein mining is conducted in a large majority of counties in the State, in some of them it being the principal revenue. As near as can be authentically ascertained there are about four thousand stamps, or the equivalent thereof, in operative quartz mills. It is also estimated that not less than three thousand five hundred of these stamps are constantly dropping upon ores. If the average duty of these stamps, or equivalents, be two tons each every twenty-four hours for three hundred days in the year, the crushing capacity would be 2,100,000 tons per annum. From information collected throughout the State, the average value of the ore crushed is not far from $7 per ton; this would give an annual gold yield of $14,700,000.

New processes are coming more prominently into notice than in the years gone by, but few of them, however, have been pronounced successes. The successful treatment of auriferous sulphides is one cause of the extension of vein mining, all of the gold mines at varied depths containing more or less gold-bearing sulphurets.

ARE THE MINES WORKED OUT?

This is a question frequently asked, and without apparent cause. Although hydraulic mining has been interdicted, and millions of dollars are thereby lost annually to the State's circulation, vein mining has not depreciated from its former prosperity. Though in some districts the earlier worked mines are often spoken of as being worked out, such statements, in most cases, are void of facts, for since the cheaper methods of mining and reduction have been established, many of the so-termed exhausted properties are being re-operated, and some are already dividend paying. Renewed activity has begun throughout the mining zone of the State; the industry shows a notable profit over last year's output, and, as a whole, mining ventures are satisfactory to the careful investor. In districts remote from railway transportation are valuable mineral deposits, which can be profitably exploited when facilities favorable to conveyance can be secured, and this can be stated of the mineral belt, where existing, from and including San Diego County to the Oregon line. It is true, as with other business ventures, there are omissions of success, but such failures are generally brought about by over-confidence, lack of knowledge, or insufficient investigation.

SILVER MINES.

Although silver does not occur as abundantly as gold in California, this metal has a wide distribution throughout the State. It occurs in paying quantities in San Diego, San Bernardino, Los Angeles, Inyo, Mono, Alpine, and Shasta Counties, and is found in several other counties, where the mines are not as yet sufficiently developed to prove their value. The industry of silver mining had been steadily on the increase up to the present year, when the extremely low price to which silver fell in the money markets of the world resulted in closing many mines which had previously been worked to their full capacity. Should silver again reach $1 per ounce these mines will again be operated.

GEOLOGICAL SYNOPSIS.

The results of Field Assistant H. W. Fairbanks' geological investigations undoubtedly prove that the Coast Ranges are structurally related to the Sierra Nevada Mountains. His examinations show that no break exists between the ranges forming the western boundary of Shasta County and the mountains in the eastern part which belong to the Sierra system, and that the existence of Paleozoic fossils west of the Sacramento River is positive proof of these deductions.

The metamorphic rocks were followed southward through western Tehama, Colusa, Lake, and Napa Counties, and it can be said with certainty that the older rocks are not Cretaceous, but belong to the same series as those in Shasta County. The metalliferous deposits of the latter mentioned county are remarkable for their variety, and almost always connected with the appearance of intrusive dikes and bosses. Near the southern boundary of the county the intrusive rocks disappear, as do also the mineralized belts, and but little mineral of any kind is to be found until the volcanic region about Clear Lake is reached.

The presence of Cretaceous rocks along the coast near San Diego was amply proved by a collection of over sixty species of fossils, many of which are new.

The western portion of the Colorado Desert, from the boundary line to Banner, was explored, and much new and very interesting information gathered.

The discovery of fossils in the metamorphic rocks of the Santa Ana range will prove of great value in solving the difficult geological problems presented in this part of the State. With the exception of a single specimen from the Mojave Desert, these are the only fossils yet known from the older rocks of Southern California.

A trip was made northward through the Coast Ranges, beginning in Los Angeles County, for the particular purpose of ascertaining the relation of the southern coast mountains to the Sierra Nevada.

The geological connection between the southern Sierras, Coast Ranges, and the mountains of Los Angeles County, with their southern extension, has been the source of much discussion among geologists, and great diversity of opinion has existed. It is believed that the work of the Bureau in this section has solved some important problems.

As a result of the work in Ventura, Santa Barbara, San Luis Obispo, and Monterey Counties, it was ascertained that the geological formations

are divisible into two great series: the younger, the Miocene-Tertiary, or oil-bearing series, and the Metamorphic Auriferous Series. This series, similar to the rocks north of San Francisco in every particular, is pre-Cretaceous, and has been intruded with granite, which is believed to be continuous with the southern Sierras. In Santa Barbara County the older series has been almost wholly covered by the Miocene-Tertiary.

A careful geological survey would be of great value in these southern coast counties in defining the areas of Tertiary oil-bearing series, for considerable capital has been uselessly expended in regions where geological investigation would have shown the futility of prospecting.

In thanking the Trustees for the interest they have taken in the Mining Bureau, it is with pleasure I call attention to the munificent gifts of Hon. J. Z. Davis, President of the Board, especially to his valued donation—the sculptor's masterpiece, the marble statue, "Rebekah at the Well," costing several thousand dollars.

I also desire to call attention to Mr. A. H. Ricketts' able article, "A Dissertation upon the Origin, Development, and Establishment of American Mining Law," to be found elsewhere in this report.

Placer County has not received the attention which its mining interests merit, for the reason that the assistant appointed to examine that locality was for a time absent, in behalf of the hydraulic cause, at Washington, D. C., and his resignation was received at too late a date for any other appointee to write up the county's mineral resources in time for the date set by law for the completion of this report.

GEOLOGY AND MINERALOGY OF SHASTA COUNTY.

By HAROLD W. FAIRBANKS, F.G.S.A.

Shasta County occupies an important position in the structure and topography of the State, being situated at the head of the Sacramento Valley, and having its surface chiefly occupied with rugged mountains; the union of the Sierra Nevada and Coast Range. It is interesting alike for the great variety of its rock formations and the range of geological time represented by them, as well as for its mineral resources, whose richness is just beginning to be appreciated. It is in this county that the Carboniferous was discovered by Dr. Trask, the first State Geologist. Since then the county has been the subject of geological investigation by the old State Survey under Professor Whitney, and particularly of late by the members of the United States Geological Survey. The geological problems here presented for investigation are of uncommon interest. Among them may be mentioned the disputed point concerning the relation of the Coast Range to the Sierra Nevada, that of the Cretaceous to the Metamorphic Series, and the possibility of the presence of older Paleozoic rocks as well as those of early Mesozoic age.

As a mining county it first came into prominence on account of the extensive placers which existed along nearly all the streams flowing into the Sacramento from the west. As the placers failed the gold and silver deposits were opened, but on account of the rebellious character of the ores the operations were not generally profitable. It is only within the last few years that quartz mining has been carried on with any degree of success. Now the county is rapidly becoming one of the foremost producers of the precious metals in the State.

In undertaking an investigation of the county for the State Mining Bureau, I have thought best to give particular attention to geology. Too much emphasis cannot be laid on the necessity of a thorough knowledge of the underlying geological features of a mineral district before attempting to give a description of its ores. In the following report I have described as accurately as possible, with the time at my disposal, the general geology of the county and the geology of the ore deposits, gained by a visit to one or more of the typical mines in each district. All the mines could not be visited in the limited time, but especial attention was given to those districts not heretofore described in the Mining Bureau reports.

The map which I have prepared to accompany the report is intended to show the areas occupied by the various geological formations and also the positions of the important mineral belts.

As yet I have had no opportunity to study the large collection of rocks made in the county, nor have the many new species of fossils from the older formations been classified, consequently the following notes are based almost wholly on field observations.

The Modern, or Quaternary, deposit of the Sacramento Valley has a

width of about 20 miles on the southern boundary of the county, stretching from Gas Point on the west, to the lava a short distance east of the Sacramento River. It consists of stratified sands, gravels, and coarse conglomerates derived from the crystalline rocks of the surrounding mountains. These unconsolidated deposits narrow northward and disappear before reaching Pitt River. In the vicinity of Anderson the deepest wells do not penetrate through them. Between Redding and Millville the drilled wells in many places pierce the underlying Cretaceous shale, the water from which is generally somewhat brackish. The Cretaceous beds inclose the modern deposits, basin-like, on three sides. The Cretaceous is covered by lavas on the east; on the north and west it rests against the Auriferous Series, which is in part Carboniferous.

I will now take up the detailed description of the county, beginning east of the Sacramento River, following the Sierra around to its junction with the Coast Range, and tracing the latter southward.

A hasty trip was made from Anderson east through Shingletown over the old Fort Crook road, to Fall River Valley, passing close by the northern base of Lassen's Butte.

The whole of this southeastern part of the county is a great lava plain, gently sloping to the Sacramento River, and reaching an elevation of 5,000 feet near the summit of the range. South of Bear Creek no deep cañons have been eroded, though in scattered spots the thin lava crust has been cut through, exposing the sedimentary beds. The surface is that of broad ridges, generally well timbered, and with more soil than is generally found on the lava.

The South Fork of Bear Creek, about a mile above its mouth, falls over the edge of the lava plateau to join the main fork where the underlying sandstones are exposed. Shales and sandstones are also exposed along the creek in the vicinity of Clark's Mill for about 2 miles. Gold has been found in the gravels underlying the volcanic tufas in several places along Bear Creek, associated with metamorphic pebbles. This indicates a former exposure of the Auriferous Series, higher in the mountains, which is now covered with lava. A thin seam of coal is reported from Snow Creek, and also some Upper Cretaceous fossils.

The elevation of Whitmore Post Office, on the Tamarack road, is 2,150 feet. North Cow Creek, 1 mile away, is 600 feet lower. It has cut down to the Cretaceous beds, which are exposed first about 3 miles above. In the north side of the creek, near Whitmore, a coal seam has been exposed; it is 14 inches thick, dipping north 30°. Up the creek thin seams of coal outcrop for several miles. One of these appears to be 10 inches thick and dips to the southeast 40°. Another aggregate of seams with clay layers between them has a thickness of 4 feet.

Where the Tamarack road strikes North Cow Creek there are large expanses of undisturbed Cretaceous sandstones, with many fossils. The ridge between this creek and Clover Creek is not high and is formed entirely of lava fragments and bowlders imbedded in a matrix of volcanic ash or sand. About 6 miles east of Millville this ridge is replaced by hills of Cretaceous shale, dipping slightly to the east and south. The adobe hills formed by this shale are about 3 miles across. On the west they are replaced by volcanic ash having a very barren surface. Near the western edge of the Cretaceous beds is a conglomerate of bowlders derived from the old crystalline rocks resting unconformably on the Cretaceous.

The Cretaceous (Chico) beds appear on Clover Creek, about 3 miles east of Millville, and are continuous along the creek and hillside, up to where the creek divides; then they continue to appear in the valleys of the different branches, the total surface area being considerable.

About a mile east of the point where the creek divides, the old Metamorphic or Auriferous Series outcrops. It is a dark green rock, generally massive, though jointed. The strike is north 70° west, dip vertical. This extends easterly about a mile, when it becomes capped by the lava. In a southeast direction it crops out for 2 miles, and on the eastern edge of the exposure is replaced by a quartz porphyry.

An interesting series of rocks appears near Mr. Whitmore's place. Sec. 3, T. 32 N., R. 1 W. At the base of the hills near Dry Clover Creek there are cliffs of undisturbed sandstone containing strata of pebbles and good examples of false bedding. A short distance west, in the same formation, are several thin seams of a good quality of coal, the thickness of which, as far as it has been explored, is not great enough to pay for working. A fourth of a mile up Galt Gulch the soft sandstones are replaced by highly altered rocks dipping north 20° to 30°, strike north 70° west. These consist of thin layers of apparently crystalline material closely resembling a fine-grained granite. Alternating with these are softer strata, largely feldspathic, which form soft white clays on decomposition. The peculiar thing about these strata is the presence in them of a layer 18 inches thick of black carbonaceous matter, containing a little coal. The strata cannot be traced all the way to the coal-bearing formation below, and it seems hardly possible that they belong to the same series, unless there has been local metamorphism. Coal has never been found in the older Metamorphic Series, and should this prove to belong to that series it would be a most interesting fact. A microscopic examination is necessary to determine positively the nature of the strata containing this coaly layer, but it is certainly very peculiar that the carbon should remain in rocks so perfectly crystalline.

Farther up this ridge, north of the Dry Fork of Clover Creek, the old metamorphics crop out; the rock is massive, light green in color, and greatly jointed, so that the bedding cannot often be distinguished. A serpentinoid diabase has been intruded into this rock, as shown in a small exposure. Patches of unaltered sandstone rest on the rocks just described, but the latter are generally covered by lava breccias; the cementing paste appears to be a ground-up rock similar to the fragments, showing the action of water.

Clover Creek Falls are about 70 feet high and very picturesque. The water falls over a cliff of the older series. The rock contains large grains of quartz in a felsitic matrix, and is somewhat similar to that south of the town of Shasta. The ridge between the falls and the Oak Run road is formed of volcanic breccia.

The Chico shales form an extensive valley for many miles along Oak Run, terminating about 3 miles southwest of Morley Post Office. They rest against the Auriferous Series, which is then exposed along the creek for a mile or more, finally being covered by the lava. A very interesting succession of rocks is shown. As we go up the creek, the first is a feldspar porphyry, in which the feldspar crystals are not generally prominent. The rock is in some places perfectly massive, in others laminated, closely resembling a metamorphic one. It often shows traces of a tufa-

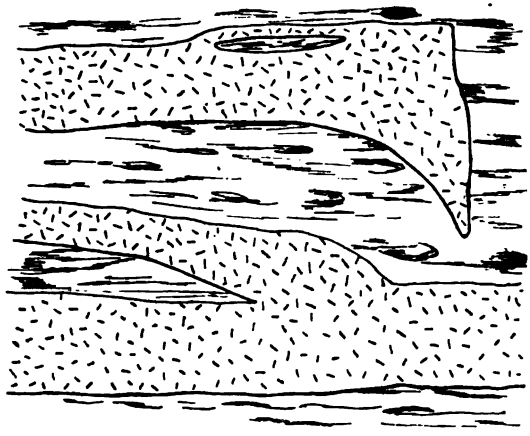


Fig. 1.

ceous character, with rounded or semi-angular bowlders a few inches to a foot in diameter and sometimes concentrically colored. The matrix appears to be of the same material. This porphyry-like rock is generally more or less crushed, presenting a flowage structure; the laminated portion of the matrix bending and winding among the pebbles. This same structure is sometimes present in the fresh portions. The lamination is north 60° west, dip vertical. In connection with this lamination there is a strong mineralization and silicification of the rock mass, sulphurets being so abundant that the surface is stained a strong yellow color. Placer gold has been found along the creek, and some prospecting done, but without success. Diabase dikes are numerous, and quite irregular in extent and direction, often cutting across the schistose lines of the porphyry. They are coarse in the middle, with prominent feldspars, and become fine-grained toward the edges, where they are often amygdaloidal with calcite. One contains inclosed a thin slab of porphyry. (Fig. 1.) One half mile up the creek the porphyry is followed by rocks of undoubted sedimentary origin, slates, and sandstones. They have a very variable strike and dip, due to the intrusion of dikes. The slates are often finely cleavable. The most prominent dike is amygdaloidal near the slate; in fresh spots it closely resembles the porphyries; a little distance from the slates it becomes laminated and somewhat mineralized, with traces of a conglomeritic structure. If it were not for the amygdules it would certainly be taken for a sedimentary rock.

The rock forming the country northwest toward North Cow Creek is chiefly of a feldspathic nature, often bordering on the porphyritic with quartz or feldspar. In one spot there is shown a plain conglomerate structure, in which the pebbles are not all alike; some are diabasic, others strongly porphyritic. Seldom is there any appearance of bedding seen, but when it is present it is very irregular. The quartzes in the porphyry do not generally show idiomorphic boundaries, but resemble those in the quartz felsites. It is probable that the greater part of this rock consists of old eruptives. There is no true bedding, and the uniform character and direction of the schistose structure indicate that it is due to dynamic action.

The ridge north of Oak Run is capped with basalt; it terminates a

half mile east of North Cow Creek, having near the end a height of 1,700 feet. Where the road crosses Oak Run above Morley's an amygdaloidal serpentinoid rock outcrops. North of the creek the road passes for a mile over shaly rocks, with occasional patches of sandstone. The slates strike north 60° west, dip 50° to northeast. The most of this rock has a porphyritic aspect and the lenticular, shaly structure characteristic of dynamic forces. The high ridge to the north is capped with basalt.

Chico sandstones outcrop in a narrow strip for several miles along Oak Run, in T. 33 N., R. 1 W. It also appears in greater mass along Little Cow Creek, north of the high ridge separating the two creeks, and it is probable that it extends continuously through underneath the lava capping. Coal prospects have been found along the sides of this ridge for several miles, but the only locality in which any development had been made at the time of my visit is on the northern slope of the ridge, about half a mile east of the Donkey Mine, in Sec. 12, T. 33 N., R. 2 W. Here the coal seams are shown in a shaft sunk a little above the outcrop. There is a total thickness of 23 feet exposed; this is cut up into numerous seams by the layers of clay. There are two seams of coal 2½ feet thick, one 15 inches, one a foot, and several others slightly less. The aggregation of so many seams in a small space makes it easy to mine, and if the beds are really as extensive as the outcrops indicate a valuable coal field exists here. The coal is apparently of good quality, though some iron pyrites occur in it at the spot where the opening has been made. A quarter of a mile to the west and a little lower than the coal beds, feldspar porphyry outcrops. This shows that it is probably only a little distance down from the coal to the Auriferous Series, and development only will show whether underneath the ridge this series rises high enough to cut off the coal. It is probable, however, that this series sinks toward the east and becomes buried under thousands of feet of the Cretaceous beds. The elevation of the coal beds is 1,900 feet. The strata are nearly level, but north of Little Cow Creek they outcrop 300 feet lower, showing a slight dip to the east. The coal is overlaid by sandstone; underneath is clay and shale.

The coal beds are exposed along the southern slope of the ridge north of Little Cow Creek. They begin on the Iles place, near the stage road, and extend up the creek for several miles. The older series outcrops just below where the road crosses the creek, but does not appear farther east; the Cretaceous beds themselves are covered by lava tufas about 6 miles up the creek. No developments have been made here, but there are apparently three sets of coal seams occurring within a perpendicular distance of 200 feet. The beds dip 5° to 10° east and northeast. The lowest is near the bed of the creek, and its thickness cannot be seen. The middle set evidently corresponds to the beds south of Cow Creek just described. The thickness is about 20 feet; elevation 1,600 feet. It consists of two main parts: one 6, the other 8 feet, divided by several feet of clay. Each division contains several thin clay seams, the thickest solid coal seam being about 2½ feet. There is no doubt but what coal is present here in sufficient quantity to mine, though the set of beds just described being inclosed in shale, much timbering will be necessary. The heavy bedded sandstones which outcrop along the side of the mountain on the north are conformable with the coal beds, and evidently belong to the same formation, though they have been reported to be Miocene. North

of this lava-capped mountain shales appear again, and about a mile south of Round Mountain the metamorphic rocks replace them. This rock appears like a tufaceous porphyry, containing much chlorite.

A considerable area of level land stretches north from Round Mountain. The underlying rock is shale and sandstone with some thin seams of coal. A high ridge of volcanic tufa rises on the east, while westward, wherever the erosion has been great enough, the Metamorphic Series rises through the Cretaceous. Near Montgomery Creek an area of the older series extends east of the stage road. The rock is generally either faintly porphyritic and fragmental, having a dark base mottled with red, or of a diabasic character with an excess of feldspar. The height of Montgomery Creek is 2,160 feet. From this point north and east for many miles the country is entirely volcanic.

The surface of the country from the top of the mountain north of Montgomery Creek to the Big Bend of Pitt River is a nearly level plateau, having an elevation of 3,000 feet, and sloping very gently westward. The deep cañons of Hatchet and Roaring Creeks have been eroded in the western end of this plateau. At the spot where the upper road to the Bend crosses Roaring Creek there is an outcrop of the Cretaceous shale. This is seen again along the road which descends to Big Bend, where it is said to contain some thin coal seams. Sandstones and shales outcrop also north of the Bend, dipping gently to the northeast, with an exposed thickness of about 400 feet. They extend up the river a short distance, also up Nelson Creek and down the river to the mouth of Kosk Creek. This creek forms the dividing line between the lavas and the older series, and it is evident that it is also the boundary between this series and the Cretaceous beds. The latter extend up the east side of the creek till hidden by the lava. Kosk Creek has cut its channel at this junction of the lava and the older rocks nearly to its source, and it has been reported that coal exists toward the head of the creek. The region north to the McCloud is one which it is almost impossible to traverse, and very little is known about it. It consists of rounded ridges rising 6,000 to 7,000 feet, perfectly barren of trees, and covered with thick brush.

The Big Bend Hot Springs issue from an ancient intrusive rock, seeming to be a diabase, though largely feldspathic. The springs vary from warm to boiling, and are scattered thickly along the river for a quarter of a mile, with a large volume of water in places. The rock along the river for 5 or 6 miles below the mouth of Kosk Creek is chiefly a massive, crystalline one, like that at the springs. Big Cañon opens into Pitt River 7 miles below the bend. On the ridge between it and Pitt River a feldspar porphyrite outcrops, quite similar to that west of Kosk Creek, but in places it is highly amygdaloidal and scoriaceous. Slates appear in Big Cañon. They strike very regularly a little west of north; dip almost vertical. The color is black to purplish. A few scattered fossils were found in them and in the washed bowlders in the bed of the creek. The cañon has been eroded in the strike of the slates, and by following it up a larger collection could undoubtedly be made. The most prominent fossil is a large-ribbed bivalve shell not found in place at this point. The character of these fossils indicates a Mesozoic age. Some of the fossils, as well as the slates, resemble the Triassic of Indian Valley, Plumas County. They are certainly younger than the Carboniferous, and, according to our present accepted stratigraphy, must be older than the Cretaceous.

In the cove, near the mouths of Hat and Roaring Creeks, there is a considerable area of sandstone and conglomerate exposed, the lava having been worn away. It terminates often in precipitous cliffs, and the very rapid descent to the deep cañon of Pitt River has given rise to several beautiful falls.

Below Big Bend, Pitt River flows for many miles in a deep, narrow cañon. Its course has been cut at the junction of the Chico conglomerates with the older series, and the conglomerates are exposed in great thickness in many places along the cañon. The lavas are stratified, showing many successive flows, often fragmental at the bottom.

One half mile west of Round Mountain there outcrop slaty argillites, much contorted; strike east and west, dip 40° north. Here occurs a small vein of black quartz, carrying a large percentage of galena and zinc-blende. Other deposits of these minerals of small extent are found between this point and the Afterthought Mine, on Crow Creek.

Several small pieces of a silver-white metal were obtained from Mr. Iles, 5 miles southwest of Round Mountain, and are now in the museum of the Bureau. They proved on investigation to be native zinc, not certainly known heretofore as occurring in nature. According to Dana, it has been reported from Australia and Tennessee, but under circumstances not wholly free from suspicion. All efforts to obtain more specimens, or to have the location of the vein divulged, have been in vain. There is, of course, some doubt with regard to the genuineness of the metal, but from the fact that a small piece of rock remains adhering to one of the specimens, and that another shows a crystalline structure, such as could hardly be artificially produced, it seems to me they must be genuine.

In descending the Reed road the first outcrop of the older series is a chloritic feldspar porphyry, with a somewhat tufaceous appearance. Two miles west of Round Mountain a large body of limestone outcrops on both sides of Cedar Creek. This extends along the creek for 1½ miles; at one spot forming cliffs 200 feet high. This height represents about the thickness of the limestone, for it dips west at an angle of not more than 10°. As the mouth of Cedar Creek is approached the strata, chiefly slates, become much steeper, with a strike a little north of west. Limestone again appears at the mouth of Cedar Creek, where it contains numerous poorly preserved fossils, chiefly brachiopods and corals of Carboniferous age. The limestone west of Round Mountain also contains similar fossils. One and a half miles below the mouth of Cedar Creek there is another mass of limestone, having a thickness of about 1,000 feet. Thin beds of limestone, alternating with slate, occur near the larger one. It is probable that all these bodies of limestone belong to the same horizon, but have been separated by the folding and crushing which has taken place.

The group of mines of which the Afterthought is the most important, is situated on Cow Creek, in Sec. 11, T. 32 N., R. 2 W. The veins occur in or near the contact of slate and porphyry. The direction of the veins is northwest and southeast; dip to the northeast. The ore is quite base, carrying copper (often as high as 50 per cent), gold, silver, and some lead and zinc-blende. It is due chiefly to this rebellious character of the ores that the extensive operations begun here proved a failure. The depth reached in the Afterthought is said to have been 80 feet; the point at which the more base ores were met.

North of the Afterthought Mine is a considerable area of slaty rocks, often finely cleavable. These apparently dip south at a high angle, but a banding across them in the opposite direction seems to show that the cleavage lines are not those of sedimentation. The same thing is noticeable a mile north on the west side of the creek, where the slates show plainly a dip south at a small angle, while the cleavage is nearly vertical. A little farther north these banded strata are conformable with the limestone, dipping 60° to 80° southwest. Between the Afterthought Mine and the limestone there is a large body of quartz porphyrite. In places this shades into a schistose rock, closely resembling a sedimentary one, but it is to be distinguished from the latter by the fact that the schistose structure runs uniformly in one direction, northeast and southwest, with a vertical dip, while that of the real sedimentary varies greatly within short distances.

Below the Afterthought Mine, to the point where the road leaves the creek, the formation is chiefly a dark quartz porphyry. What is known as the Backbone road follows down the divide between Cow Creek and Pitt River. The ridge is high and narrow, with a very abrupt descent to the river. The highest point of this ridge for a mile consists of gray and black slate; strike north 30° to 40° west, dip vertical. Farther west the ridge is covered with lava, but there are occasional outcrops of the older series. This underlying rock is generally a dark flinty one, often with minute crystals of feldspar, and a flowage structure much resembling an ancient lava. Northwest of the lower end of the Reed toll road, the rock, where not covered by lava, is a massive green one, with traces of a porphyritic structure. It is undoubtedly an intrusive porphyry. The Reed road after leaving Cow Creek passes over lava tufas for several miles. West of this, blocky argillites are met; strike north 30° to 40° west, dip 50° northeast. These are followed by a mile of dark crystalline rock, which is overlaid by Chico sandstones on the west. The sandstone is replaced by shale toward the mouth of Cow Creek. These shales, wherever exposed in the foothills, form a heavy adobe soil. Characteristic fossils are abundant. The sandstone is but scantily covered with soil, and weathers out in great knobs and dome-shaped masses. On Dry Creek the shales are well exposed, showing a dip from 5° to 80° and numerous faults. Sandstone carrying an abundance of fossils outcrops on Stinking Creek. Near the mouth of the creek numerous brackish sulphur springs break out. The water is very disagreeable to the taste, and deposits both salt and sulphur. This region was recently the scene of a petroleum excitement, but no trace of oil could be found. The sandstone rises northward in higher barren ridges for a mile, and terminates in a conglomerate resting on the Metamorphic Series. The latter consist of slates, which strike north and south, dip 30° to the west. They are black, hard, and jointed, and cut by dioritic dikes. Farther north, in a gulch which heads in Bare Mountain, the slates are extremely metamorphosed; strike west 15° south, dip 80° south. Dioritic dikes continue to be numerous. Up the gulch as far as the Copper City road the diorite porphyrite dikes continue. Their outlines are very irregular and they often appear as mere bunches, but preserve a general northwest and southeast direction. The slates as a whole are so metamorphosed that there is no noticeable contact phenomena. The strike is north, to north 15° west, dip 20° to 30° west, for 2 miles southwest of Bare Mountain.

It is probable that granite underlies this region at no great depth, and that the numerous porphyritic dikes are offshoots.

Between Bare Mountain and Silverthorn Ferry, argillites are the prevailing rock. They lie nearly flat. At the river the strike is north 40° west, dip 40° southwest. Thin strata of limestone are occasionally seen. Between Copper City and the ferry, the rocks, though greatly broken, strike northwest and dip southwest.

It is difficult to give an intelligible description of the mines about Copper City. It has been many years since any work has been done here, and the old workings are inaccessible. The great excitement occurred in 1862–63. Mills were afterward erected, and as the ore appeared to be present in inexhaustible quantities no regular system of development was entered upon, but it was obtained in the easiest possible way, generally from surface openings. The ore is what might be termed medium grade, carrying both silver and gold. When the undecomposed portions were reached, which was generally but a short distance down, the free milling processes were of no use; and after an attempt to remodel the works so as to adapt them to a reduction of base ores, they were wholly abandoned. At the time of my visit only a few prospectors were at work on Bully Hill and vicinity, and a part of these were engaged in placer mining.

The mineral deposits at Copper City occur generally in a feldspar porphyry, which has been intruded through the slates in great masses and not in the narrow dike form. There is not much regularity about these bunches, and the slates in consequence dip and strike in every direction. The mineralization is no more regular than the geological features. The ore bodies are not veins in the usual sense of the term. The only veins in the district are quartz, and they are barren. The ore occurs, however, in irregularly mineralized areas in the porphyry. These might be termed chimneys, and are in all probability as permanent in their downward continuation as fissure veins, but far more irregular.

The body of porphyry at Copper City containing the ore deposits extends northerly, though not continuous, about 2 miles, terminating in dikes. These bodies of porphyry are generally elongated in a northwest direction. The mineralization in this district shows feebly as far south as Silverthorn Ferry, and northward it does not extend much beyond Bully Hill. It is not certainly known whether this porphyry is a part of that great area extending in a westerly direction from the Peck Mine. There is certainly no prominent mineral deposit in the intervening region. The porphyry at Copper City often presents that tufaceous character noted in other places, and the origin of which is so puzzling. The ore is gray copper, containing gold, silver, antimony, and copper. Zinc-blende and galena are often present, and also iron and copper sulphurets. On the surface the mineralized areas are represented by a red spongy mass, in which the gold is free or partly so; the other minerals being reduced to carbonates or oxides. The character of the ore is much the same as that at the Peck and Afterthought Mines. The gangue contains no quartz, but instead a large quantity of heavy spar and calcitic compounds derived from the alteration of the porphyry.

A great amount of work was done on the Excelsior Mine at Copper City. Two tunnels, one 1,100 feet, the other 400, were run without striking the ore, and a shaft was sunk 125 feet on the top of the hill. Beautiful specimens of native silver were found near the surface in this mine

when first opened. The mine is said to have been abandoned on the supposition that it was worked out, but I see no reason for thinking that the deposits are on the surface merely. The ore in this mine was characterized by a large amount of zinc-blende.

The Exeter Mine was opened to a depth of 60 feet. The body of ore opened up is supposed to be better defined than most of the deposits in this district. All the ore milled was taken from near the surface, where it was easily worked. The direction of the ledges is northwest and southeast, but it is not likely that this regularity continues far.

Bully Hill lies about 2 miles north of Copper City. It is a great mass of mineralized feldspar porphyry, red, and easily decomposed on the surface. The red gossan capping is distinguishable from a long distance. The surface has been worked off and milled over a considerable area, and the gulches below, though worked for years, still contain much placer gold. Everywhere the hill seems to have been worked down to the undecomposed ore, and then abandoned.

The Jenny June Mine has a shaft down 100 feet. Most of the work was done on the mine in 1862, when a tunnel 1,000 feet long was run. The ore is not as base as in most of the mines.

The Popejoy Mine has been opened by a tunnel and shaft. A large body of ore was struck in this mine, but only the decomposed portion was touched.

The Recorder Mine lies on the north side of Bully Hill. A 200-foot tunnel has been run and a body of almost pure copper sulphurets struck.

The Bully Hill ores are, as a rule, easier to work than those at Copper City.

In summing up the characteristics of this district it may be said that the amount of ore is immense, but it is medium low grade with rich spots; that, while it has paid abundantly near the surface, no method has yet been successful with the base, undecomposed ores. Carrying as they do gold, silver, and copper, some method will yet be devised to reduce them on a paying basis.

Between Bully Hill and Madison's, 5 miles above, on Squaw Creek, slaty rocks are the only ones seen. In fact, up Squaw Creek, nearly to the boundary of the county, no more intrusive rocks appear.

The great beds of limestone which form the summit of the divide between Squaw Creek and Pitt River for a number of miles, strike across Squaw Creek about 9 miles above Madison's and become less prominent northward. In fact, it is not continuous, but swells in bunches, then pinches out. It is conformable with the slates, having a vertical dip, and contains very poorly preserved fossils. Traces of fossils appear also in the slates, but no specimens could be obtained. This belt of limestone extends north to the summit of the divide between Squaw Creek and the McCloud River. In this section the hills are brushy and steep, with very little good timber. The valleys are narrow and contain but a small amount of level land. The country is picturesque, but almost unknown, except to prospectors. The height of the valley at Kelley's is 1,500 feet. Strata of a coarse, fragmental rock are interspersed in the slates; frequently they contain rounded pebbles of felsitic and porphyry-like appearance.

Five miles north of Madison's, the limestone, which at the point where Squaw Creek crosses it, dips 80° southwest, turns and apparently

in part caps the hills, with a slight dip to the east, and in part pitches at a much greater angle in the same direction on their eastern slopes. There is evidently a sharp fold, the nearly horizontal part lying to the west and presenting bold cliffs hundreds of feet high. The highest points rise to about 4,000 feet. Six miles above Madison's some fossils (brachiopods) were found in the slates between the limestone and Squaw Creek and apparently underlying it. The limestone itself contains but few fossils until the southern extremity of the high ridge is reached, and there they are abundant and well preserved. At this point, just north of the trail from Madison's to Pitt River, the limestone folds over sharply to the east and assumes a vertical dip. A close examination of this high limestone ridge showed that little of it approximates the horizontal, but that the great mass dips to the east. At the southern end of the main body is a portion nearly level, rising in rugged cliffs and pinnacles. It has been crushed to such a degree that the bedding is often destroyed. The color is generally gray, but it is thickly intersected in all directions by veins of white secondary calcite. It does not appear to extend farther southeast than Pitt River, and in all probability does not belong to the same horizon as the limestone on Cow Creek. From Pitt River up to the summit of the ridge the course of the limestone is north 40° west, dip vertical. At the top of the ridge great crushing has taken place, and it has been thrown into a north and south direction, which position it keeps for many miles, when it again bends toward the west. Southwest of the southern limestone peak, between it and Squaw Creek, the slates strike north 60° to 70° west. The greatest width of the limestone is about one mile, but in the center of the highest part of the ridge another sharp crest starts and runs south 50° east, for a distance of perhaps 2½ miles.

The fossils from these limestones are remarkable in many ways. A part of them are very finely preserved, and differ in character from any before found in the State. Another curious thing is that no corals of any description were found. From position the limestones might be supposed equivalent to those on Cow Creek, but there is a total dissimilarity of fossils. It is my belief that they represent a geological horizon younger than the Carboniferous and older than the fossiliferous beds of Big Cañon.

In a gulch at the extremity of the main limestone range there is an opportunity to study the transition from limestone to slate, made doubly interesting from the fact that a portion of the fossils in the limestone can be followed for 1,000 feet into the slates. The limestone first becomes slaty, then argillaceous, and finally there appears blocky and fine cleavable slates. Fossils can be traced all the way for 1,000 feet across the strike of the slates, and at that point the ammonites are very abundant as impressions merely. At two spots, one three fourths and the other a mile in a southwesterly direction, traces of fossils were found in the silicious slates.

The slates continue west from Bare Valley about 3 miles, with dikes of porphyritic rocks. Then a change takes place, and the prevailing rock becomes a fine-grained, greenish crystalline diabase, with occasional dikes of porphyrites. Between the branches of Stillwater, on the Redding road, there appears a bunch of white crystalline limestone. On the west branch of Stillwater the Chico sandstones make their appearance. These are followed by a compact volcanic ash, like that at Mill-

ville. This is followed by Quaternary gravels, and about Sand Flat there is a large area, perhaps 2 miles in extent, covered by the Chico sandstone, rich in fossils. The western part was covered to a considerable extent by auriferous gravels and much of it has been sluiced off. The gold in the gravel must have been derived from the range of hills near Churntown, where there are a large number of gold-bearing veins.

It is difficult to determine the character of the massive green rocks in the vicinity of Churntown. There is no defined crystallization nor any traces of stratification, but they are probably ancient and highly altered intrusives.

As one goes north from Redding the Auriferous Series is met first about 2 miles south of Buckeye, and is frequently seen along the road from this point to Stillwater Post Office. South of Buckeye it is a white feldspathic rock, but northward it is replaced by green dioritic rock and occasional strata of slate.

Two miles south of Stillwater the rock is a coarse micaceous diorite. Dikes of diabase and quartz porphyry also appear.

Between Bass and the limestone, or Gray Mountains, the rock varies greatly. There are quartz porphyries, massive green varieties, and some of undoubted sedimentary origin.

The limestone forms a ridge of steep, jagged rocks, rising 2,400 feet. It is a continuation of the McCloud limestone, though at the point where the Pitt River breaks through it pinches out. The body of the limestone dips east 40° to 50°, but on the western side of the mountain peak it is nearly level. The strike is irregular, showing a longitudinal compression. It is north and south to north 25° west. The limestone lies almost wholly in intrusive rocks of varying composition. It is broken up into detached fragments, and seamed and cut by dikes and bunches of this rock. Diabasic and dioritic rocks seem to prevail. They are fine-grained, and along the western contact are strongly impregnated with iron, and leave a deep red gossan capping. Since my visit a body of good iron ore has been developed here. The limestone seems not only to be broken on the surface, but does not go down deep. In many places it merely caps the hills, a fact shown in the transverse cañons. These apparently detached masses extend in a north and south direction. The northernmost has a thickness of about 800 feet, thinning out toward the south. In the course of 3 miles it almost disappears, save for widely detached bodies of small size. One is a quarter of a mile south, a second half a mile west, and a third is 4 miles southwest. The wide separation of these limestone bodies, which certainly belonged to the same horizon, indicates very clearly the eruptive nature of the fine-grained greenish rocks which prevail in this section. The rock east of the limestone is closely related to the quartz porphyries. One mile east of the limestone is a north and south contact of the slates with the eruptives. The slates dip east at a very small angle, while 2 miles east, on Bare Mountain, they dip west at about the same angle. This forms a synclinal, whose inverted arch can be seen plainly from the north.

At one point on the western slope the limestone is full of finely preserved corals and brachiopod shells. This is where Dr. Trask collected the first Carboniferous fossils found in the State. A narrow dike of granitic rock outcrops between Bass and the limestone range. This consists of chlorite, quartz, and a little feldspar, and closely resembles the rock on Middle Creek below Shasta. The dike widens northward,

and at the ferry over Pitt River it is about a mile across. Here it is less decomposed, showing hornblende crystals and generally a small amount of feldspar. It might be termed a hornblende granite. It decays to a great depth, and in this decayed mass are nodules and dike-like masses of fresh rock. From the mouth of the McCloud north to the United States fisheries, this hornblende granite appears in contact with dark semi-crystalline rocks, probably metamorphic, or with green granular rocks closely resembling intrusive diorite, but from stratigraphical relations shown near the Fisheries, it appears that it is a metamorphic sandstone. This hornblende granite is the rock referred to by Drs. White and Becker of the United States Geological Survey, as being older than the sandstones and slates underlying the Carboniferous. However, judging from the fact that the rock is generally fine grained near the edges, and ends in very irregular and ramifying dike-like projections, it seems that it must be intrusive and younger than the slates. From the mouth of the McCloud up Pitt River the rocks are all crystalline, or nearly so, until about a mile and a half below Silverthorn Ferry, where highly metamorphic and contorted sedimentary strata are met; strike a little east of north, dip a high angle to the east. The crystalline rocks consist of amygdaloidal diabase, diorite, and porphyries, with massive green rocks of indeterminate composition. A body of iron ore outcrops on the north side of the river. It shows a heavy gossan capping and scattered bunches of magnetite. Northward along the western slope of the limestone mountains the iron ore is thickly scattered over the surface. It is said to occur in great quantity in places. Several small developments have been made and ore shipped. The ore lies near the contact of the limestone with the eruptives. The deposit is very similar to that near Stillwater.

The scenery is very picturesque about the United States fisheries. The McCloud is a clear, cold stream of great volume, rising in Mount Shasta. On the east there extends for many miles a high and rugged limestone range, known as the Gray, or McCloud Mountains. The geological features about here are varied and of great interest. Carboniferous fossils are quite abundant, and there is a large variety of intrusive and metamorphic rocks. A short trip was made up the river, and the mountains on the east climbed until the limestone was reached. With scarcely any exception, the series of rocks exposed between the limestone and the river is intrusive. Near the river is a fine-grained diorite, then a brecciated porphyry, changing to a quartz feldspar porphyry. Above this are dikes of diorite, narrow strata of metamorphic rock, and amygdaloidal diabase, in the order mentioned. The limestone rests on these intrusives and stretches out long, narrow arms down the mountain to the west. Between the arms are bodies of diorite. The limestone dips northeast to east, with greatly varying angles. At one place it is not over 30°, at others nearly vertical. Whitney states that the thickness of the limestone is 1,000 feet, but I believe it is much greater, probably twice that amount. At the southern end of each of the main peaks the strata seem to have been crushed upward from the south. On the western side of the range the debris from the cliffs has been cemented by percolating lime water, so as to form extensive tufas 20 to 30 feet thick. Judging from the manner in which the limestone has been broken up, the crystalline rocks underneath are certainly younger. Fossils are scarce in the main body of limestone at

this point. Large caves are said to exist in this limestone range, but time did not permit of their exploration. A half mile below the Fisheries the hornblende granite terminates. It is succeeded northward by diorites and feldspar porphyrites, with some greatly altered metamorphic rocks, showing a steep dip to the northeast. It seems to penetrate the semi-crystalline rocks and become fine grained on its edges, with generally a sharp contact. It is quite probable that this rock is the upward termination of a large body of granite, to which the extreme metamorphism of the sedimentary rocks is due. A little below the Fisheries a gulch comes in from the west, and it is seen that the intrusives are soon replaced in that direction by sandstones, argillites, and grauwackes, in such a highly metamorphic condition that the stratification is not often seen. The metamorphism grows less toward the west, and in the course of a mile we reach soft shales and blocky slates, with a strike a little west of north and variable dip toward the east. Black slates appear on the Sacramento River road a mile west of the Fisheries; strike east and west, dip 15° north.

The sedimentary strata about the Fisheries are very highly metamorphosed, and it is frequently difficult to distinguish them from the dikes of diorite and diorite porphyrite which occur here. Just above the Fisheries, on the west side of the river, there are dark, argillaceous, fossil-bearing strata, rather thick bedded. These contain disconnected layers of impure limestone; strike a little west of north, dip 30° to the east. The argillites and not the limestones are fossiliferous here.

A few yards to the north, these fossiliferous rocks become jointed and highly metamorphosed, blending downward across the strike into rocks that become pyritiferous and very compact, then more feldspathic and granular, while the northernmost exposure is a massive heavy diorite. It is very difficult to say whether there is a direct continuation downward of the fossiliferous strata, which become more and more crystalline, or whether it is a dike, whose junction with the metamorphic rocks can not be seen on account of similarity of appearance. At the southern end of the argillite outcrop is a slightly porphyritic diorite, whose eruptive nature is unquestionable on account of the sharp contact which it shows.

Argillitic rocks, frequently containing fossils, occur along the trail which leads up the river to Campbell's place, 8 miles above. There is much similarity, both in the character of the strata and in the fossils. Dikes of diorite and strata of quartzose and of feldspathic composition separate the fossiliferous beds. The rocks are in great part metamorphic, but the bedding is not prominent. The slaty rocks strike north 20° to 60° west, and dip from 30° northeast to vertical. Thin beds of limestone are associated with these rocks, but they do not carry fossils.

The limestone peaks along the east side of the McCloud River extend in a north and south direction, but the strike of the formation is generally northwest and southeast. The repetition of the limestone bodies in a north and south direction, as well as that of the fossiliferous beds along the river, is undoubtedly due to sharp folding or faulting, whereby the same strata are repeated several times. If this were not so the thickness of the limestone would be immense. The limestone mountains were climbed south of Campbell's and found to be underlaid and cut up by dikes of diabasic rock. Radial arms of limestone extend down the mountain from the main ridge in every direction, and are often entirely isolated by the intrusive rock. At one place a purplish, faintly por-

phyritic rock underlies the limestone. It, with some other rocks much jointed and shivered by dynamical action, seems to have been left adhering to the limestone when it was caught in the intrusive masses. Considerable local variation exists in the strike and dip of the limestone; dip from nearly level to a high angle to the northeast. Fossils are reported to be abundant on the mountains 2 miles south of Campbell's, but the locality could not be found.

The formation is well exposed along Campbell's Creek. It appears to be pseudo-diorite and other highly metamorphosed rocks. These rocks extend to the divide on the east, slates not appearing till Squaw Creek is reached. One mile east of Campbell's the slates strike north 50° west, dip 45° northeast.

The McCloud through the greater part of its course flows with a swift current between steep, and often rugged, but not precipitous, mountains, with scarcely any bottom land. Timber is not abundant on the mountains, and what there is is largely oak. About a mile above Campbell's the course of the limestone carries it across the river. It appears in detached bodies for some distance up to this point. West of the river it rises in a high ridge for several miles, then in a second one, while on the east side of the river, opposite, and about 6 miles above Campbell's, are other high limestone peaks. The country rock continues to be a green stone to a large extent, often certainly of sedimentary origin.

About 9 miles from Campbell's, on the north side of the river, the limestone occurs in thin strata, alternating with hard, green or purplish rocks; dip 55° northeast. On the south side the dip is half that. It is overlaid by conglomerates, quartzites, and other granular semi-crystalline rocks. Underneath are argillaceous rocks, filled with imprints of branching forms (bryozoa). This is the last of the limestones on the McCloud. The beds extend off in a northwest direction, toward the head of Hazel Creek. On the divide they form a high mountain, rising fully 6,000 feet.

Twelve miles north of Campbell's the rocks are chiefly greenish to purplish conglomerates, very hard and compact.

East as far as the divide separating the McCloud from Squaw Creek, there is much hard metamorphic rock, with quartzites and greenish semi-crystalline, fragmental rocks, together with some probably intrusive. In the hills just south of the river, 12 miles above Campbell's, there is an outcrop of a dark calcareous argillite, rich in fossils. The strata dip to the east 30° and strike a little west of north. They are about 3 miles east of the limestone. The fossils are probably Carboniferous. Rocks similar to these described outcrop along the river to the north of Chatterdown Creek. Up the creek appear green conglomerates, slates, diorites, and thin-bedded quartzites. The latter occur in very regular strata, a few inches to a foot thick, with thin, soft argillitic layers between; strike north 40° west, dip 65° northeast. Eastward appears a green rock, often fully crystalline, often conglomeritic with pebbles of eruptive rocks, porphyries, and porphyrites, sometimes amygdaloidal. Judging from the pebbles in the creek, black slates must outcrop toward the head of the creek. The great mass of the rocks are semi to fully crystalline, and generally massive. This is a very interesting field for the study of metamorphism. Nothing certain can be said until a microscopic examination has been made. It is certain that there are some intrusive rocks in this region, but the origin of most of the massives is in doubt.

Petrosilex is another common rock. One mile south of the mouth of Chatterdown Creek is a purplish porphyritic rock. Fossils are reported from limestone at the head of Chatterdown Creek, but the locality was not visited. The McCloud has an elevation of 1,300 feet at the mouth of Chatterdown Creek. The mountains rise about 2,000 feet more, with occasionally higher peaks. The mountains are very brushy and it is almost impossible to travel over them, except on the trails. Between this point and Campbell's the river is bordered in many places by one or two terraces of water-worn pebbles, the highest one sometimes being 200 feet above the river. Near where the river cuts across the limestone above Campbell's is a red porphyritic rock, resembling that seen under the limestone farther south.

The presence of quartzose rocks and conglomerates associated with the McCloud limestones, generally overlying, would in itself indicate a different geological horizon from that of the limestone on Squaw Creek, which is almost exclusively associated with slates.

Many of the conglomerates or tuffs contain green, dark red, or purplish pebbles, similar in appearance to the massive rocks, but no non-conformity is apparent in the whole series, so that it is not likely any formation which now appears could be the source of the pebbles. The coarse conglomerates generally overlie the limestone, while quartzite and sandstone occur on both sides.

Between the mouth of Campbell's Creek and the Fisheries, on the east side of the river, fossils are frequently seen. At one spot imperfect trilobites were obtained. Three miles above the Fisheries a cherty limestone was seen, with a strike nearly east and west.

Soft shales become the prevailing rock one and a half miles west of the Fisheries. They are cut by many dikes of diorite, and farther west by diabase. Although very irregular in strike and dip, there is certainly no break between these shales and the highly metamorphosed rocks on the McCloud.

It is to be noted that the apparent slight degree of metamorphism shown by the shales is no sure indication that they have not been subjected to metamorphosing influences, for in many cases, action which will harden quartzose rocks and sandstones will have apparently but little effect on clayey rocks, owing to their impenetrability. In addition, slates and shales soften near the surface, while more quartzose rocks maintain their solidity.

Near the summit we find the shales in contact with hard sandstones, which are almost metamorphosed to quartzites. On Salt Creek is a body of quartz feldspar porphyry, in the decayed portions of which the idiomorphic crystals stand out finely. The summit of the divide is 1,600 feet. At the Sacramento bridge it is 1,100 feet.

The western slope of the hills forming the divide is very barren; the trees are few, and the soft shales decay and wash away so easily that in many places even brush does not grow. For some miles after leaving the McCloud the shales strike in a north and south direction, dip east, and as the Sacramento is approached they strike east and west, dip north at a small angle. Near the bridge they are greatly broken and crushed. They are chiefly black slates, with frequent strata of dark quartzite and quartzose conglomerates. They assume all positions in strike and dip in the course of a few rods.

The Quaternary gravels on which Redding is situated give place,

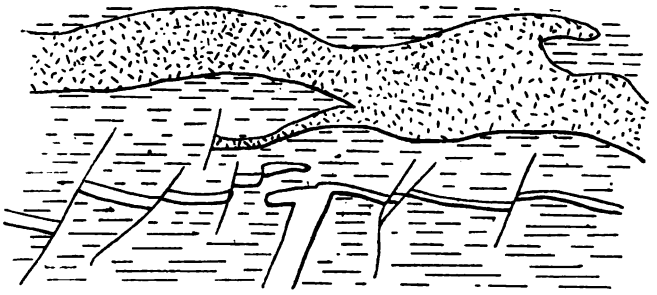


Fig. 2.

about a mile up the Middle Creek road, to small outcrops of sandstone, probably Cretaceous. This is followed by the Auriferous Series, which outcrops along the river for about a mile south of Middle Creek. It consists largely of massive rocks, dark and fine-grained, and often showing faintly amygdules of calcite and other minerals. The rock varies from chlorite schist, through dark intermediate varieties, to a syenite with distinct hornblende crystals. The greater part is intrusive, but there are places where there is a distinct sedimentary structure; strike north and south, dip 80° to the east. Along Middle Creek there are good exposures, and the eruptive nature of at least a part of these rocks is shown. Fig. 2 shows an irregular dike, which is scarcely distinguishable from the rock it intersects, save for its strongly marked boundaries. A peculiarly faulted quartz vein lies near it. This dark rock gives place to a coarse granitic one with large quartz veins, chlorite, and a little feldspar. The granite appears perfectly massive, though showing the effect of great crushing. It begins as bunches and ramifying dikes and finally becomes the country rock. It extends along the creek as far as Shasta. It is sometimes replaced by dark chloritic dikes. Irregular and bunchy quartz veins are to be seen, and in these prospecting has been done. The granite is very rich in quartz, and though no fresh hornblende appears in it here, yet from the shape of the chloritic bunches, they were undoubtedly derived from hornblende; making the rock originally a hornblende granite, undoubtedly of an intrusive nature, but at present reduced to the extreme stage of decomposition. As before mentioned, this rock is identical in character with that at the ferry on Pitt River. South of Shasta this granitoid rock contains less feldspar and more chlorite, forming a massive, dark green rock, rich in quartz. There is no apparent bedding, but occasional strata of softer rock; strike north 25° east, dip 80° southeast. Near Centerville, and from there westward, the rock shows plainly a strike north 65° west, dip 80° northeast.

Two miles south of Shasta is the Thompson Mine. There is a large vein here, carrying rich sulphurets and free gold; direction north 20° west, dip 45° northeast.

At Centerville is an old river channel running nearly north and south. A shaft of 100 feet has not touched bottom. Bedrock appears on both sides, giving a channel between 200 and 300 feet wide. In the early days Middletown and Centerville were towns of considerable size, supported by extensive placer diggings, but now their locations can hardly be recognized. South of the Muletown Mountains the rocks are metamorphic schists; strike north 75° west, dip 80°

north. About Muletown there is an interesting series of formations to be studied. Extensive and rich placers were worked here in the early days, but as yet no extensive quartz mining has been successfully undertaken. On the northern end of the mountain the rock is similar to that south of Shasta. In places it contains but little chlorite, and blends toward the south into an almost pure massive quartzite. More study is necessary to determine the relation between this apparent quartzite and the chlorite granite. Hornblendic, chloritic, and talcose schists replace this rock on the southern end of the mountain; strike often a little south of west. On the western side of the mountain are dikes of a beautiful porphyritic diorite. These have a north and south direction. Similar dikes are also found on the northeastern side of the mountain. The porphyritic diorites on the west slope have been intruded in the quartzites, which narrow to a point toward the south, and which have on the east, running nearly north and south, dikes of syenite and light-colored quartz porphyry. The dikes are followed southward by dark massive felsitic rocks, while syenite occurs on the west. Just south of Muletown is an outcrop of micaceous syenite. Between this point and Clear Creek nothing but syenite is seen, and it also appears to be the prevailing rock over a considerable extent of country west of the creek, but is separated from the granitic diorite of Mount Bally by a considerable width of metamorphic rock. One half mile south of Muletown all the bodies of intrusive rock are replaced by slates and light-colored talcose schists. The main quartz veins of this district run north and south. Nearly all the surface on the western slope of the mountain down to Clear Lake was very rich in placers. One principal vein, running north and south over the mountain, is traced for some distance at the contact of syenite and quartz porphyry. West of it is a vein in the syenite and on the flat at the foot of the mountain are other veins, either in the syenite or at the contact with a stratum of hornblendic rock. These veins dip east at a very high angle. The main vein after it leaves the syenite continues across the southern end of the mountain in the schists, cutting them at a large angle and preserving a constant course. These veins are developed only by surface work, except in two instances, where tunnels of some length have been run. The ore is mostly sulphurets, with little free gold below the water line. The region has been a favorite one for pocket hunters. The sulphurets are rich, but there is no extensive development to show the real character of the district. On the north end of Muletown Mountain a rich east and west vein occurs. In the syenitic granite just south of Muletown, for a distance of over 100 feet east and west, there are minute parallel veins of quartz, one eighth to one and a half inches wide, which strike north 80° west. They dip west 85°, and are remarkably even and regular. The veins are from 4 inches to 1 foot apart. Some show a decay of the syenite along each side with a little appearance of slickensides, indicating a fissure; while others are frozen to the rock Some seams parallel to these show polished sides and no quartz. As the quartz weathers out, the syenite, though perfectly massive, assumes the appearance of a bedded rock. Some cross cracks exist, which in one case has caused a vein to jump; not a faulting of the rock, as the adjoining veins are not disturbed. (Fig. 3.) These are barren, though irregular and bunchy veins near by contain gold. A compact conglomerate appears about 2 miles north of Horsetown, in the sides and

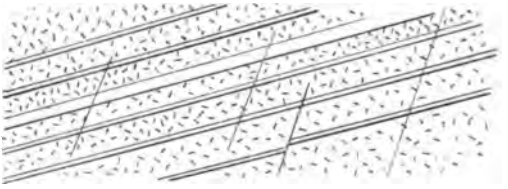


Fig. 3.

bottom of the gulches. This is formed of the various rocks which go to make up the southern end of Muletown Mountain. It dips southeast at an angle of 15°, and in that direction is gradually succeeded by sandstones. A minute quartz vein appears in this conglomerate, filling a crack which has been formed since its solidification, for the vein follows a direct course through pebbles and matrix.

Sandstones, nearly horizontal, and containing some fossils, outcrop on Jackass Flat, a little south of Centerville.

North and west of Horsetown there is a small outcrop of granite. A brown sandstone rests on the granite. It is inclined east at an angle of 20°, and contains numerous fossils, among which are ammonites. This is the locality from which the Horsetown beds were named. They constitute the next to the lowest division of the Cretaceous in this State. The fossils occur in concretionary nodules.

Horsetown is another example of the early mining town, once sustained by the placers, but now entirely gone to decay. One mile east of Horsetown, on the north side of Clear Creek, is an outcrop of the Metamorphic Series. It consists of fine, cleavable, and highly altered slate inclosing a body of gray limestone. The strike is north 30° west, dip 40° to the east. The limestone appears to be not over 100 feet thick and lenticular in shape, as it outcrops for a few hundred feet only. A number of faint coral forms were gathered; they weather out on the surface. Lime has been quite extensively burned here at some period. A short distance west of the limestone the slates strike 65° west, and are quite talcose.

South of Clear Creek the country is entirely covered with stratified gravel deposits, sloping gently toward the Sacramento. The streams have worn shallow valleys in them. North of the creek, where the gravels are shallow, much placer mining has been carried on. A half mile west of the limestone the strata dip 30° to the east, but between Horsetown and Centerville, wherever exposed, the dip is very steep.

Going east from Centerville we soon strike a porphyritic diorite similar to several of the dikes on Muletown Mountain. Occasionally strata of green schistose rocks occur in it; strike north and south, dip east. This diorite outcrops along the road 2 miles, though I do not think it extends far north and south. On the east it is finally covered by Cretaceous sandstones, rich in fossils, which dip southeast at a small angle. The sandstone does not extend far until it becomes covered by the Quaternary gravel.

The Old Diggings and Churntown districts, north of Redding, were not examined as extensively as some other portions of the county, for the reason that a lengthy report was given of them in the last annual publication of the Mining Bureau.

The line of hills which border the Sacramento River on the east between Redding and the mouth of Pitt River, belongs to the Auriferous

Series, and the rocks are well deserving of that designation. The gulches leading both east and west from this ridge were very rich in gold, but now the chief interest in this section centers in the numerous gold-bearing quartz ledges. The Churntown district lies on the east, and the Old Diggings on the west. Both are very similar in regard to geological structure and in character of ores, though more silver is to be found in the eastern side. This line of hills seems formed of parallel dikes of fine greenish, crystalline rocks and greatly altered quartz and feldspar porphyries. Between them are strata of highly altered sedimentary rocks. Both dikes and slaty rocks have in general a strike a little east of north and west of south, and a very steep east or west dip. The ore is sulphurets and free gold, with generally very little silver. The veins occur at the contact of porphyry with slaty rocks, of two different kinds of porphyry, or of porphyry with massive greenish dikes, which are so decomposed that no precise name can be given to them.

In some of the mines the ore is chiefly sulphurets, in others part sulphurets and part free gold. Owing to the uniform strike of the dikes and country rock in the Old Diggings district, the veins are regular and have the gold distributed quite evenly. The mines in this district are improving with depth, and it can be safely said that they are true fissure veins. The Texas Consolidated Mine is one of the deepest, being down at the time of my visit 640 feet. The vein sometimes reaches a width of 14 feet, with good fissure walls. Three veins are worked in this mine. They contain no barren quartz.

The Calumet Mine is one of the southernmost in the district. The vein strikes a little east of north, and dips east 60°. The walls are part slate, part porphyry. The vein crops for nearly a mile and is supposed to be identical with one of the main veins farther north. The gold is largely contained in iron sulphurets. The free gold is very fine.

The bedded rocks exposed along the railroad between Middle Creek and Mr. Paul's reduction works show a strike of north 10° to 30° west, dip usually west. The rocks do not cleave well, but are joined and show polished seams. There are several dikes of a handsome syenite porphyry. There are also many greenish dikes, which are so altered that it is impossible to discover their original composition, and it is often difficult to distinguish between them and the metamorphic rocks. Amygdules of calcite and epidote are thick in places, and they are good indications of the rock's origin. Many quartz veins appear, sometimes at the contact of the schists with the eruptives, and sometimes in the eruptives.

Judging from the amount of alteration, the dikes represent two periods; the porphyritic dikes are in all cases the younger; the older are compact, fine grained, and possess a green color. They are either massive or schistose.

The surface rock under the gravels is often decayed down 25 to 40 feet. Hence, the time must be great since their surfaces were exposed to erosion. This period probably antedated the deposit of the great body of gravels and conglomerates filling the head of the Sacramento Valley.

The Eureka Tellurium Mine is located near Middle Creek. Here tellurides of gold and free gold were found in a shaft sunk 70 feet. A tunnel has been commenced to tap the vein 100 feet below the shaft. The rock in the tunnel is fresh and undecomposed. It is partly a chloritic petrosilex, and partly an aphanitic diorite. In the diorite is a

dike of syenitic feldspar porphyry. The great majority of the dikes in this section follow the strike of the Metamorphic Series.

South of Middle Creek, and a mile southeast of Shasta, are some hills having as their center syenite and chloritic diorite. The chlorite granite to the east and south is filled with small, irregular gold-bearing quartz seams. Much surface work has been done on these little veins in the search for pockets. Bands of dark rock extend through the granite in an east and west direction. A little southeast, in Sec. 5, T. 31 N., R. 5 W., is a prominent vein, exposed in a direction north 18° east on the crest or western side of a line of hills; the dip is 70° east. The vein is known as the Oro Fino. The hanging wall is diorite, the foot talcose schist. The southern end of the vein is in Section 8. It terminates very abruptly in a great mass of quartz on the summit of the hill. The northern end is covered by gravel. The ore consists of iron and copper sulphurets and fine gold. A short distance to the west is a series of veins in chloritic schist, and running a little west of north.

The Silver King Mine is located in the same township, Section 9. The ore is antimonial silver in white quartz.

West of Shasta there are no dikes, as mentioned by Professor Whitney; simply the white granitic rock so extensively developed east of the town. It has little chlorite and closely resembles arkose, consisting of quartz and feldspar in a granular form. The toll road runs over a hill, 2 miles west of Shasta, which is formed of a white quartz porphyry so greatly altered that its true nature is hardly recognizable. Its intrusive origin is shown by the almost perfect idiomorphic form of many of the quartzes. This porphyry mass is over a mile wide. In the center is a stratum of schists. West of the porphyry, and extending several miles past Whiskytown, is a green rock, often semi-crystalline and varying from massive to schistose. It is not certain whether this lamination is that of sedimentation or that of pressure. The strike is north 40° to 50° west; dip, a high angle to the northeast. The hills on the north are brushy and show no crystalline rocks, save an old amygdaloid. Two miles east of the Tower House a crystalline rock outcrops along the road and in the hills on the north. It has a feldspathic ground mass, in which are thickly imbedded green hornblende crystals, also some quartz. It is probably a diorite, but is not well differentiated from the semi-crystalline rocks adjoining on the east. At one spot a dike of quartz porphyry occurs in the green schists. These schists belong to that class of rocks very numerous in Shasta County, whose origin is doubtful. Much more study is necessary to determine the question.

Black, finely cleavable slates outcrop three fourths of a mile east of the Tower House; strike north 50° west, dip 70° northeast. Mill Creek flows into Clear Creek at the Tower House. Up that creek the slates are soon replaced by feldspathic and chloritic schists, and at a distance of 2 miles by a micaceous diorite, often gneissoid.

Down Clear Creek the slates become hard and blocky. A careful search in the slate about the Tower House did not reveal any fossils. One mile north of the Tower House the slates dip south, and are followed by conglomerates of slate and silicious pebbles. The slates are so highly metamorphosed that they ring on being struck. There is no quartz mining in the vicinity of the Tower House, but the placers have been found very rich along Clear Creek. The Tower House has an elevation of 1,330 feet.

The rock exposed along the more northerly of the two toll roads leading over the Trinity Mountains is almost wholly slate for 4 miles; strike 40° to 50° west, dip northeast. The slates finally become irregular in strike and dip, and are followed by silicious conglomerates nearly to the summit, when granite appears. Only one dike, a porphyritic diorite, was seen on this road. Green massive silicious rocks outcrop along the southern road for 2 miles west of the Tower House. Then there is about a mile of black slate not greatly altered, being soft and jet black. Three miles up this road dioritic granite appears. In its vicinity the black slates are partially metamorphosed, having a minutely wavy surface, caused by the development of small needle crystals. This appearance is noticeable for a hundred feet or more around the granite. A harder slate follows for a quarter of a mile. Near the main body of the granite the slates strike north 60° west, dip 65° northeast. The exact contact cannot be seen here, but coarse dioritic granite seems to terminate abruptly against the slates. There is no doubt, whatever, that the granite has been intruded through the slates, and is consequently younger. Slates appear again along Clear Creek, a little south of French Gulch; they dip north 40° to 60°, strike east and west with great variations.

The rocks exposed along Kline's Gulch, which leads up to the Gladstone Mine, are slates and fine silicious conglomerates. The strata turn and dip south 70° to 80° at the Gladstone Mine, and in general the dip of the veins is the same. The walls of the vein worked in this mine vary greatly, sometimes black shining slate, at others silicious conglomerates or fine-grained silicious slates. In many places there are bunch-like bodies, or narrow irregular bands of a light green feldspathic dike, probably once a diorite. The regularity of the fissure at this place is undoubtedly due to the presence of this dike, for the country is so broken that it is hardly possible that a well-defined vein could exist for such a distance as is here shown. Polished quartz and clay seams are characteristic, with a general ribbon character of quartz. The ore is worked for free gold and sulphurets, which are rather fine. The sulphurets occur in black layers and bunches in the quartz.

The Gladstone Mining Company owns a number of claims along this series of veins, and have opened a continuous body of quartz 1,900 feet in length, and a depth, as far as exposed, of 900 feet. This depth is measured from the top of the hill to the lowest tunnel. The greatest width of the vein is 22 feet; average width, 4 to 5 feet. The greatest amount of work has been done 700 feet below the top of the hill. The Gladstone Company owns 8,500 feet of claims. On the west there are over 3 miles of claims located on this same series of veins. The mountains are high and the gulches steep and narrow, so that but little pine is found.

A second examination was made of the arcose-like rock west of Shasta, and it was determined to be a quartz porphyry, whose character was masked by the crushing which the quartz crystals have undergone. They are often drawn out in lenticular forms, arranged parallel. Some are half an inch long and full of cracks. The unbroken ones still show plainly the crystal facets. A half mile west of Shasta is a large body of diorite, followed eastward by the chlorite granite before described. In many places the granite differs from the quartz porphyry just described, by a greater amount of chlorite and less feldspar. The granite appears for 3 miles along the road to Iron Mountain. There then appear strata

of quartzite varying from light to dark, and generally containing chlorite and feldspar. The rocks outcropping along the last 3 miles before reaching Iron Mountain show a greatly varied nature. Whenever bedded rocks appear the strike is northeast, dip west. There are many dikes of fine white quartz porphyry, and others of diorite. Toward Shasta they are seen penetrating the quartzose rocks in long irregular arms. A dike of orbicular diorite outcrops a mile south of Iron Mountain. The surface portions of the dikes is always greatly decomposed. Some of the white quartz porphyries are very closely related to the quartzites, and no line can be drawn between them. Strata of quartzite are sometimes inclosed in the porphyry dikes. Near the foot of the grade leading up to Iron Mountain the quartzites contain numerous rounded bowlders or long lenticular bodies of a dark, fine chloritic quartzite. Southward the quartzite takes on more feldspar and chlorite and seems to blend into the chlorite granite. It may possibly be an acid differentiation of the same intrusive mass.

The Lost Confidence Mine is situated on Iron Mountain, near the summit of the range, 8 miles north of Shasta, at an elevation of 2,400 feet. The ore deposits occur in a body of porphyry of varying composition. A mile west of the mine slate replaces the porphyry, and extends west to the Gladstone Mine. An arm of the porphyry projects a little west of south, across the head of Whisky Creek, forming a V-shaped area.

The porphyry in the gulches about Iron Mountain is undecomposed, exhibiting quartzes with crystalline faces. A half mile above the mine the porphyry has a fluted or columnar cleavage, resembling the columnar structure often seen in basalt. The ore lies in a very fine quartz porphyry, which changes at times into a chloritic felsite or petrosilex. The chlorite is present in large scales, probably representing crushed crystals.

A heavy iron gossan outcrops in great projecting masses just above the workings of the Lost Confidence Mine, on Slick Rock Creek, and extends up the mountain, forming its crest fully 1,000 feet above. This important mineralized belt extends about 10 miles northeasterly, across Spring and Boulder Creeks to Squaw Creek. A number of valuable silver mines are located on it. The Lost Confidence Mining Company owns about a mile of this deposit, beginning at Slick Rock Creek. One of the most interesting and valuable properties owned by this company is a body of pure hematite ore, covering about 40 acres. No development has yet been made, but every advantage exists for a great industry here. The iron is apparently inexhaustible, very pure, and with an inclined tramway built to the Sacramento River could be cheaply placed on the cars. The iron is separated from the silver vein by a dike of porphyry 300 feet wide. There are two ledges or deposits carrying silver, separated by a stratum of decomposed quartz porphyry 1 to 3 feet wide, and dipping to the northwest. The foot wall or silver vein is 10 to 30 feet thick. It consists of copper sulphurets, which assay 20 to 30 per cent copper and 10 to 30 ounces silver per ton. The hanging wall vein is formed of almost pure iron sulphurets, 80 to 150 feet thick. It is worked for both gold and silver, containing them in the proportion of 10 silver to 1 gold. A large amount of native copper is saved every month by allowing the water which runs from the mine to pass through a flume several hundred feet long filled with scrap iron.

The Backbone Mining District is located in the same body of porphyry

as the mines at Iron Mountain. It outcrops for 2½ miles along Squaw Creek. The Squaw Creek Mines are located in about the center of the porphyry, but are of a very different character from those just described, carrying gold instead of silver. The deposits belong in the category of fissure veins, while the mineralization of the silver belt, the northern continuation of which is seen on Squaw Creek, about a mile below the mines, is not that of a defined fissure, though a certain amount of crushing must have preceded the mineralization, but is, instead, a kind of impregnation along an irregular line. In Shasta County the peculiar mineralization giving rise to the prominent iron gossan on the surface is confined to the large bodies of porphyry. These ore deposits are almost free from quartz and are characteristically silver-bearing, in contrast to gold-bearing quartz ledges.

Between the mouth of Squaw Creek and the porphyry are many dikes of dark amygdaloidal porphyry and porphyrites. There are also strata of quartzite and other metamorphic rocks. A green rock, massive or schistose, outcrops along the river, below Kennet. It resembles the green rock in the Old Diggings and Middle Creek districts.

South of Squaw Creek, on a high ridge, are a number of valuable silver prospects, accompanied by heavy gossan. Another gossan outcrop occurs three fourths of a mile up the creek from the Uncle Sam Mine.

The slates appear a mile west, forming the summit of the divide. The contact with the porpyhry follows a line about north 20° east. The contact is indicated by the sudden termination of the timber which grows on the porphyry. The slates are much metamorphosed near the porphyry, and have a very irregular strike, seeming to abut against it. The strike is north 50° west to east and west, dip generally to the south. Small dikes of quartz porphyry and diorite porphyrite occur in the slates. This body of slate extends northeasterly toward the Sacramento River, but is said to be followed farther north along the divide by another body of porphyry.

The Squaw Creek Mines are in a very acid quartz porphyry, often termed quartzite. The rock is greatly decomposed, but the presence of idiomorphic quartz and pale green talcose aggregate indicates an intrusive rock. The veins have a general east and west direction. Two veins are worked in the Uncle Sam Mine. A long crosscut tunnel shows the decomposed quartz porphyry with traces of hornblende crystals. In this rock are traces of a green rock, and one broad mass of a beautiful diorite porphyrite, with feldspar crystals an inch long. The veins dip north conformably with a schistose structure developed in the porphyry. The large vein dips about 49°, the small one 65°. The ore consists of copper and iron sulphurets and free gold. At the time of my visit the greatest depth worked in the Uncle Sam Mine was 525 feet. The veins are 150 to 200 feet apart; average width, 6 to 7 feet. The other mines in the vicinity have much the same character as the Uncle Sam.

Fig. 4 is a cross-section sketch from Squaw Creek Mine to the coal beds in eastern Shasta County.

The highest peaks about the head of Squaw Creek rise 4,000 feet. The old Squaw Creek trail to Kennet goes over the high ridge north of the creek. The porphyry is seen along this ridge for about 2 miles, when it terminates at a considerable body of limestone, which is, together with some slates, inclosed by the porphyry. This body of porphyry does not go much farther north, nor do the dark eruptives seen along

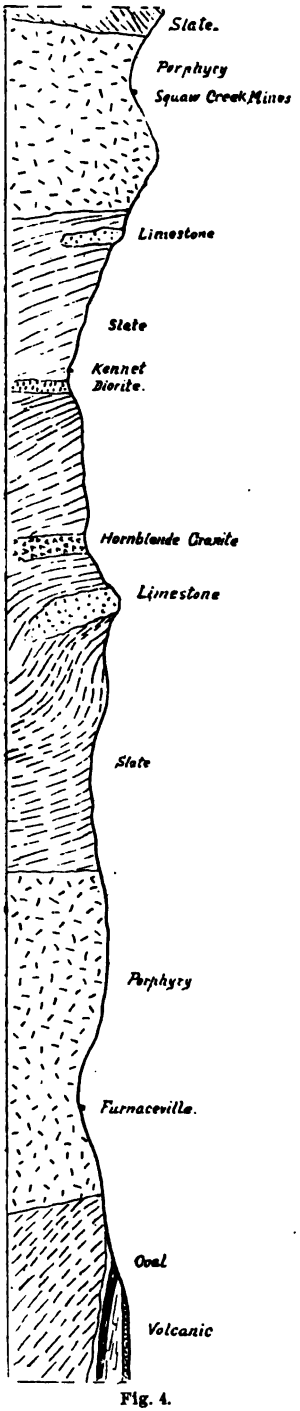


Fig. 4.

the new grade extend over the ridge. Instead, the rock is almost wholly matamorphic below the limestone. One small patch of limestone is reported on the hill south of Squaw Creek. Another occurs between the trail and the new grade, one on the trail, and the largest between the Backbone Creeks, while north of Backbone Creek there is another small outcrop. The limestone crossed by the trail is rich in fossils, chiefly corals, as is also the large area on the north. The fossils occur along the southern side of the outcrop. The slates on the west strike north 20° east, becoming east and west, and finally east of the limestone north 30° to 45° east; dip nearly vertical. Green quartz porphyry occurs along the summit above the limestone. The limestone seems to merely cap the hills in places, the greater part of it lying high on the ridges. In places the dip is steep, and it comes down nearly to Backbone Creek. The fossils are similar in all the separate areas.

The rocks up Backbone Creek are massive and green to feldspathic for a mile, when slates appear. They are greatly faulted, metamorphosed, and crushed, often having a shining black appearance. They are sometimes nearly level for several thousand feet. A little farther and there are dikes and broad masses of quartz porphyry, sometimes almost flinty. Farther up the creek, northwest of the limestone, there is not much intrusive rock. Bowlders of silicious conglomerates are very abundant in the creek.

The fossils in the limestone are exclusively corals, and in places the branching stems form almost the complete mass and weather out very finely on the surface. In fact, the great mass of the limestone seems to be made of corals, which are nearly obliterated. This is the first discovery of Paleozoic fossils in Shasta County, west of the Sacramento, and is very interesting as proving the unity of the so-called Coast Ranges and the Sierras.

An excellent quality of lime is burned on Backbone Creek.

A basalt flow terminates a short distance south of the old Sacramento River bridge. It extends northward, though more or less broken, to the head of the river, connecting with the lava fields of Siskiyou County. Where first met it forms a low table-land

along the west side of the river, rising about a hundred feet or more. It is about 40 feet thick. Underneath are washed gravels, once the bed of the Sacramento River, and down which the lava flowed. The basalt being harder than the bedrock, the river cut its bed by its side, frequently crossing it and reducing it to disconnected patches on the sides of the valley. A little north of Delta the lava rises 200 feet above the river, and is nearly 100 feet thick.

Slate, together with sandstones, forms the country rock for 2 miles up Dog Creek; strike north and south, dip 30° east. Above these are quartz porphyries, dioritic rocks, and porphyritic conglomerates or tufas, probably eruptive. There are also many dikes of a beautiful diorite porphyrite. The latter rock occurs as dikes and bunches traversing the country everywhere in the vicinity of the Dog Creek Mines, 6 miles from Delta. At the Dog Creek Mines slate appears again and forms the rock toward the divide. It is cut by dikes of a greenish, slightly porphyritic rock and diorite porphyrite. At the contact of the dikes with slate are the gold-bearing quartz veins. The greater portion of the gold is found in iron sulphurets. Very little development was shown here at the time of my visit; however, the veins do not appear to have a great deal of regularity, often pinching out or being cut off by cross dikes.

Slates are the only rocks exposed along the Sacramento River between Delta and Slate Creek. The dip and strike are exceedingly various. A large area of serpentine begins north of Slate Creek and forms the mountains northward between Shasta and Trinity Counties. It is met first about a mile and a half west of the road, in the form of more or less small detached masses intruded in the slates. Good exposures cannot be seen, on account of the great amount of soil covering the hills. In the serpentine are dikes of white granular mineral, probably malacolite. The serpentine extends west to the county line, the upper waters of Slate Creek heading in it. It is generally massive and hard, with some talcose layers running through it.

In years past considerable placer mining has been done on Tom Neal Mountain. The source of the gold has never been discovered, but it is quite likely that it has been derived from the talcose strata in the serpentine, which in some places prospects a little. The gold has a black coating, which is proof of its origin in the serpentine. Traces of silver have also been found. At one spot a tunnel was run, in an attempt to find the veins. It cut a diorite dike and serpentine schist, which is full of large cubical pyrite crystals. Other dikes of malacolite were also seen here running north and south. South of Boulder Creek another dike of this rock was found. It contains scaly molybdenite disseminated through it, forming a very pretty rock. Very beautiful specimens of foliated talc were found in the serpentine on Boulder Creek. The talc layers often contain pseudomorphs of calcite after pyrite. Octahedrons of magnetite are also numerous in some of the talc schists. Actinolite is also found here. These crystals are not found in the massive serpentinoid rocks. Chromite occurs in spots, but not in sufficient amount to work. North of Little Slate Creek the serpentine approaches nearer the Sacramento River, and at Portuguese Flat it appears by the road. It continues to crop along the west side of the river as far as Southern's. It is generally bordered by altered diorites or green schists. The diorite forms high mountains east of the river. The mountains formed of diorite are more heavily timbered than those of serpentine, and the serpen-

tine supports a better growth than the slates. The diorite extends a mile up Hazel Creek, and is there replaced by slates, which strike a little east of north, dip 50° to 60° east. The slates, together with much metamorphic rock like that on the McCloud, extend eastward to the head of the creek. Placer mining has been carried on for many years along this creek, but no veins have been found, though quartz is abundant.

Bunches of very coarse hornblendic rock are scattered through the serpentine, and in places it becomes gradually finer, blending into the serpentine. Although a large part of the serpentine of the State has been derived from pyroxene and olivine, yet I believe that this body, forming the mountains west of the Sacramento, and extending into Trinity County, have resulted chiefly from the alteration of hornblendes with some feldspar and olivine. Chromite is mined in places along the west side of the Sacramento River, and occurs abundantly in the washed gravels in the valley. The lava table-land continues along the river, chiefly on the west side, and while it decays to form a very fertile soil, yet makes an exceedingly rough road. North of Southern's the serpentine retreats to the northwest, and syenitic gneiss takes its place along the river. Five miles north of Southern's this strikes east and west, and dips at a high angle to the south. Near this point the river rises rapidly, and from there to its source flows on the lava which fills its ancient channel, instead of cutting through it. The lava gradually widens toward the north, and only in places is the bedrock exposed near the river. A fine view of the Crags is to be had from the mouth of Castle Creek. The creek is full of a great variety of granitoid and serpentine bowlders. Serpentine is found in places less than a mile up the creek. Its extent westward is about 7 miles, when it is succeeded by slate to the top of the divide. The slate strikes a little north of west, dip 30° north. The serpentine shows much variation, and has associated with it coarse and fine diorites. The serpentine extends many miles northwest into Siskiyou County.

The granitic rocks of Castle Crags are on the boundary between Shasta and Siskiyou Counties. They consist of jagged pinnacles, presenting the appearance of having been shattered vertically. The rock varies greatly in texture and composition; from that which is fine grained with more hornblende than mica and little quartz, to coarse porphyritic varieties with pink orthoclase in large finely formed crystals, and much biotite. In another direction it approaches quartz feldspar porphyry, having but little mica or hornblende. The peaks approach within a mile of the river.

At the Washington Mine the dikes are numerous, and vary from a dark, fine-grained variety with large porphyritic crystals of feldspar, to those with an almost granitic structure. The Niagara is much higher up the hill, but is in a similar formation, the rock being porphyry of different kinds. Long crosscut tunnels show the country rock very well. Four veins have been worked. The main Niagara vein, as well as the others, runs east and west, parallel to rather irregular dikes. The main veins dip to the south; one of the others to the north. In the lowest tunnel no vein appears. The character of the walls in the deepest workings is not distinguishable from those in the tunnel, 200 feet above where the vein is prominent; sometimes swelling to 10 feet, at others pinching to a seam of crushed porphyry. Bunches of slate crushed to black shining masses are inclosed in the porphyry. These are very

irregular, and wherever they encroach on the vein it loses its gold to a great extent. The bunches of slate are sometimes very small, but at the lower tunnel near the entrance is a mass several hundred feet thick. The walls of the northern vein are somewhat different from each other: The north wall is a felsite, the southern a coarse diorite porphyrite.

The summit of the divide between the Deadwood Mines and the Niagara Mine has an elevation of 4,300 feet. The rock is argillitic, but a little distance down the western side of the mountain occur dikes of porphyry, and granite. The granite at Deadwood seems to be the northern extremity of the granitic mass of the Trinity Mountains. The porphyry dikes are undoubtedly offshoots.

The mines of Deadwood are partly in porphyry and partly in granite. The granite lies mainly to the west of the town, where it outcrops for some distance along the road. Down the mountain argillitic rocks again appear, and strike east and west; dip north.

Near the base of the grade which leads up to Bully Choop the rock is a hornblende schist, changing to talcose schist; strike north and south, dip a varying angle to the west. About 5 miles up the grade is a dike of porphyritic diorite. The rock becomes more quartzose, showing many varieties of a talcose quartz schist, or sericitic schist. The latter are often of a shining white appearance. A mile east of the divide are dikes of diorite porphyrite running north and south. The schists assume a direction nearly east and west, and dip to the north, often at a small angle. The rock is quite uniform to the southern base of Bully Choop peak, where it strikes north 60° to 70° west, dip 65° northeast. The schists become more crystalline as the mountain is approached, turning to a hornblende schist, which in places becomes a pseudo-porphyritic hornblende gneiss. The main peak of the mountain consists of fine-grained serpentine, with considerable coarse hornblende and feldspar rocks. The serpentine is often somewhat schistose, especially on its borders. There is an abrupt transition from the hornblende schist to the serpentine. The latter formation is 1 mile wide from north to south, and 3 miles from east to west, lying about equally on both sides of the divide. The serpentine is succeeded on the north by thin-bedded micaceous hornblende gneiss, rich in the dark minerals. This is followed by fine-grained rocks formed of quartz and feldspar, and in the course of several hundred feet there is an abrupt transition to a coarse hornblende granite, often slightly gneissoid. One dike of granite extends a little way into the schists. The contact runs parallel to the bedding of the schists, both in the case of the granite and of the serpentine. The granite extends north to Mount Bally, west 8 or 10 miles into Trinity County, and east nearly to Ono. A contact of the schist with the serpentine a half mile down the mountain shows that their boundaries are irregular, and small bodies of schist appear in the serpentine. Near the divide, a half mile south of the serpentine, are two bodies of white crystalline limestone. The limestone is reported to extend, though not continuously, 2 miles eastward, while another outcrop lies west of the divide. The schists on the north of the serpentine dip south 70° to 80°, while those on the south dip north.

This mining district contains veins conformable with the hornblendic and quartzose schists. They extend from some distance west of the divide in Trinity County, over the southern shoulder of Bully Choop, where the main development has been, to the Sunny Hill Mines, near

the base of the mountain. The ore is characteristically gold-bearing iron and copper sulphurets, with some free gold. Much of it is quite base, carrying arsenic and iron in addition to copper. The ore belt has a width of about half a mile. Within this distance are a number of veins which occasionally show a thickness of 20 feet. The quartz is a bluish white variety. The walls are simply the country rock. Dikes of porphyrites were met in the tunnels, but they seem to have no relation to the ore deposits. Bunches of serpentine and granitic porphyry outcrop on the side of the mountain above the old mill. Extensive works were once carried on here, but it seems that they were unsuccessful, not from the lack of gold-bearing quartz, but from the inability to save the gold. With proper manipulation of the ores, this ought to become an important mining district. The height of the mines is 5,200 feet. They are reached by a grade 14 miles long, beginning near Watson's store.

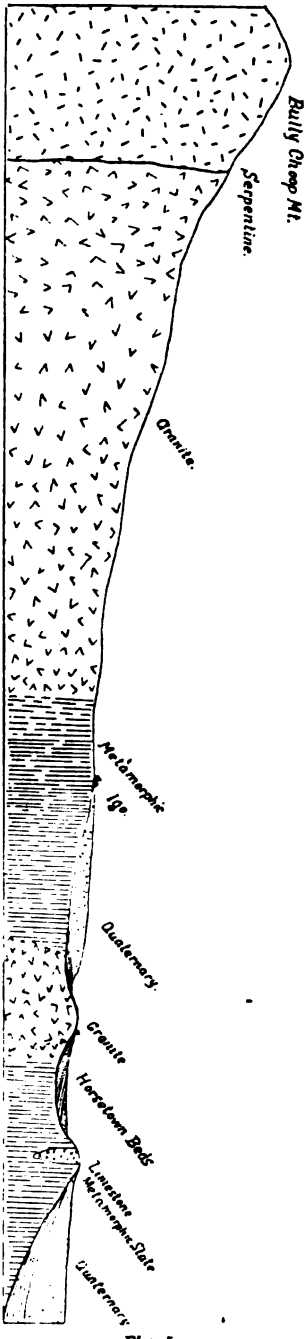


Fig. 5.

Chanchelulla Mountain, southwest of Bully Choop, and rising nearly as high as that mountain, consists largely of quartzose and talcose schists. (Fig. 5 is a section east from Bully Choop through Horsetown.)

The shales of the Horsetown beds are well exposed in the creek beds about Ono. The noted fossiliferous localities lie between 1 and 2 miles below the town, on the Cottonwood and its branches. The granite appears about a mile west of Ono, and extends in a northeasterly direction, appearing 3 miles away on the road to Igo. The Horsetown beds terminate in coarse conglomerates resting on the Metamorphic Series and granite. This boundary follows an irregular line from Watson's store northeasterly, passing a little west of Ono and near Igo. More or less gold is found in these basal conglomerates. Many of the bowlders resemble silicious conglomerates in French Gulch. Sandstone is the chief rock seen along the road from Igo to Ono. It dips only 15° to 20°. Igo is situated at the western extremity of the modern gravels, which extend toward the Sacramento River in very even, gradually sloping ridges.

At Piety Hill extensive hydraulic mining has been carried on, and large amounts of gravel still remain to be worked.

The rocks exposed for 1½ miles below Igo

belong to the Auriferous Series, and consist of quartzose argillites and some slate; strike nearly east and west, dip north. These are followed by diorite, or a feldspar hornblende rock, similar to that west of Muletown. Two and a half miles west of Igo granite succeeds this diorite. The South Fork Silver Mining District lies but 3 miles west of Igo. The veins cover a stretch of country 4 miles in diameter, and are situated wholly in the granite, or, perhaps, more accurately speaking, in the diorite, except those on the east, which lie at the contact of the granite with hornblende or argillitic schists. Near the contact the granite is greatly decomposed, and this portion also carries silver veins. One vein occurs in the schists outside of the granite. The veins on the eastern side run a little east of north, dip east, while those in the granite as a general thing run north 45° east. Those near the contact are, perhaps, the best defined. These also carry more silver and less gold, together with galena, zinc-blende, and copper. Those in the granite may or may not have gouge seams. Some veins are almost pure galena, carrying some silver. In others there is galena and iron pyrites rich in gold; there is no free gold. In still others there are both galena and arsenical pyrites rich in silver. Much of the gold is very high grade. No mill for reducing the ore has yet been put up. A number of arrastras were working along the creek at the time of my visit, but they save, of course, only the free gold in the decomposed surface ores, the silver being allowed to wash away. The veins in the hard granite are somewhat bunchy, but are numerous and rich. The greatest depth reached, 200 feet, was in the Chicago Mine. The rest of the work done here has been surface work. At the time of my visit there was not enough development to show the character of the deposits.

The road from Igo to Gas Point lies over a smooth gravel ridge, which extends in a southeast direction north of the Cottonwood. South of the Cottonwood the gravel thins out, and has been mined over a large extent of country west of Gas Point. Cretaceous shales outcrop over most of the country between the forks of the Cottonwood. Near Gas Point they are covered by a volcanic ash, which is in turn covered by gravels. The ash is very loose and soft, and in sluicing off the gold-bearing gravels on top, ditches were dug in it. The ash contains fragments of pumice 4 to 5 inches in diameter. The ash has been cut through in places, and between it and the bedrock were found petrified trunks of trees and charred stumps, producing a poor quality of coal. This body of pumice and ash must belong geologically to the great deposit of that character on the west slope of the Sierras, and antedates, of course, the gravel period. A gravel ridge runs east and west for several miles between the North and Middle Forks of the Cottonwood, and it also has been largely mined over. The gravels have been worked to within 2 miles of Anderson. Looking north from this point, the gravel ridge which extends southeast from Igo presents a remarkably even slope, and must have been deposited by Clear Creek, when its volume was much greater than at present.

NOTES ON THE GEOLOGY AND MINERALOGY OF PORTIONS OF TEHAMA, COLUSA, LAKE, AND NAPA COUNTIES.

By HAROLD W. FAIRBANKS, F.G.S.A.

At the close of the work in Shasta County, the main range of the coast mountains was followed south to San Francisco Bay, for the particular purpose of continuing the study of the question of the relation of the Coast Range to the Sierra Nevada. It seems strange that with all the geological work done in the State, no efforts had ever been made to determine from a lithological and stratigraphical standpoint the actual relations existing between these two systems of mountains. Professor Whitney, the former State Geologist, has repeatedly made the statement that the Coast Ranges seemed to blend into the Sierras, and that it was utterly impossible to draw the line of demarkation between them on structural and lithological grounds, and yet maintained at the same time that the southern continuation of the metamorphic rocks of Trinity County, which he could not separate from the Sierras, belonged to the metamorphic Cretaceous. This statement was made in spite of the fact that lithologically a large part of these metamorphic rocks was very similiar to those of the Sierras. Geologists have ever since reaffirmed the views of Professor Whitney, asserting that the metamorphics of the Coast Ranges are Cretaceous, but upon what foundation I cannot find out. It was my purpose to follow southward the Paleozoic rocks of Shasta County to their contact with the supposed Cretaceous, if such a contact did occur. But if such contact could not be found, it could be reasonably asserted that the rocks were not Cretaceous, but belonged to the older series.

Everywhere in the State a strongly marked non-conformity exists between the Cretaceous and the older series, which should make their distinction easy.

The Coast Range takes a bend toward the southwest in southern Shasta County and becomes quite low, being less than 4,000 feet where the Hay Fork road crosses. In the extreme southwest portion of the county it turns again toward the southeast and rises considerably higher, maintaining an elevation of 6,000 feet for nearly 100 miles, several peaks rising to about 8,000 feet. Cretaceous shales rise high against the eastern side of the range and form all the lower barren hills in western Tehama County. The trend toward the southeast, of the main ridge, terminates in a high peak known as Tom's Head, after which the course of the mountains is more southerly.

The Humboldt trail was followed west from Pettyjohn's, on the Cold Fork of the Cottonwood, with the following results: A quarter of a mile west of the ranch is a bed of limestone inclosed in the shale and dipping easterly about 45°. It has a fetid odor when struck and contains imperfect fossil remains. The strata become much steeper westward, and begin to consist of coarse sandstone and heavy beds of conglom-

erates, with small hard pebbles. On Salt Creek they are so disturbed and crushed as to be hardly recognizable as belonging to the Cretaceous, a little to the east. They are frequently vertical or dip to the west, showing an overthrow. In the cracks produced by the sharp plications and crushings are seams of calcite. The pebbles in the conglomerates grow larger to the west. They consist of quartzites and porphyries. Until the older series is met the strike is east and west to northwest, dip vertical. Saline springs are abundant, and the strata are frequently considerably altered. The valleys are narrow, and the hills covered with dense brush.

About 4 miles east of Pettyjohn's the Metamorphic Series was encountered, but the contact with the Cretaceous was hidden. This older series consists first of quartzites, quartz schists, and argillites, in which has been intruded dikes of serpentine. The latter is generally laminated in a northwest and southeast direction. The metamorphic rocks have a vertical dip, and strike 50° to 60° west. North of the trail and just west of the serpentine is a body of gray semi-crystalline limestone, showing no fossils. In manner of weathering and general appearance it closely resembles the McCloud limestone. A little farther west and south of the trail are several other bodies of limestone. The larger one is inclosed in shaly argillites, containing some indistinct coral forms and a poorly preserved shell 3 or 4 inches long. A large pebble of an ancient amygdaloidal rock was found in the limestone. West of the limestone, near the base of Tom's Head, occurs a feldspathic rock, often massive, followed by thin cleavable shales. The rocks met as one ascends the mountain are, first, green quartzose and chloritic schists. The same rock continues to the summit, but becomes more metamorphosed and contorted. Tom's Head is connected with the north Yallo Bally by a high ridge, along which the trail passes. Though in places the green schists are not contorted, yet over the greater part of the distance to the north Yallo Bally they are greatly decomposed, folded, and silicified, by the deposit of secondary quartz in narrow veins and bunches more or less in the line of apparent stratification. These form the summit of the Yallo Bally and Mount Linn. This rock varies from a chloritic or talcose quartz schist to a quartzose talc or chloritic schist. It is crumpled in fine lines and curves, as if a mighty force had been exerted on it parallel to the stratification. No dikes of any description were seen west of the serpentine. The rocks strike very irregularly, but in general a trifle to the north of west. To this east and west strike is due the course of the ridges which extend toward the Sacramento Valley, and the direction of the deep cañons which head between them. The rocks are very similar to those on Bully Choop, south of the mines.

No coarse conglomerates were seen on Elder Creek above Lowery's. The shales and sandstones join the serpentine on the west. The strike is quite irregular, while the dip increases as the serpentine is approached.

About 4 miles west of Lowery's, and 1 mile east of the serpentine, the characteristic Lower Cretaceous fossil, aucella, occurs abundantly. Near the serpentine the shales dip vertically, sometimes inclining to the west. Particularly is this the case near the junction, and instead of resting on the serpentine, they appear to have been tilted up and metamorphosed by it, being blackened, hardened, and much broken near the contact. The line of junction is quite wavy, bunches of serpentine projecting into the slates. The stratification of the slates does not con-

form to the contact line as it would to a certain degree if deposited on the irregular surface of the serpentine. The serpentine, however, is laminated parallel to the line of contact and is greatly decomposed. Calcite seams run through it in every direction, and to some extent in the slates also. This is the first instance in which the relative ages of the serpentine and Lower Cretaceous could be made out. There is no doubt that the serpentine has been intruded through the shales, upturning and slightly metamorphosing them. In the face of such phenomena I do not see how any one can support the theory of the metamorphic nature of the serpentine. Above the serpentine are hornblende schists and highly altered slates belonging to the older series. At the time of the serpentine outburst, and at later intervals, there were undoubtedly uplifts of the high ranges, which all together give the high angle of dip to the shales.

It is worth noticing that the serpentine dikes occur more frequently than anywhere else at the contact of the Cretaceous with the older series, showing a line of weakness at that point.

The serpentine dike narrows before Thome's Creek is reached, and breaks up into smaller ones, with strata of the older series between them. The serpentine is bordered on the east by a large body of fine-grained diorite, which weathers so much more slowly than the shale that its boundary on the east forms the edge of a steep, high ridge for many miles; a very marked feature in the topography of the country. The metamorphic rocks west of the serpentine consist of quartzites, jasper, hornblende schist, and firmly cemented conglomerates. The Cretaceous shales on the east for at least a mile are exceedingly broken, faulted, and folded on each other, producing graceful, wavy lines, both vertically and horizontally. A mile from the edge of the shales there is an outcrop of granular limestone, full of specimens of brachiopods and aucella. The general elevation of the country occupied by the shales about Paskenta is 1,000 feet. A bend in the serpentine at Thome's Creek causes a great curve in the shales, which appear nearly 2 miles farther west on the south side than on the north. The strike of the shales follows the bend in a general way, but it is very broken.

At the lower end of the cañon of Thome's Creek a dike of serpentine has been intruded, metamorphosing the shales for nearly 100 feet. They are hardened and impregnated with calcite, having the stratification obliterated for 200 feet. The calcite is, of course, a secondary product, derived from the decomposed serpentine. Evidences of dynamic action are very pronounced in the serpentine. It presents the appearance of a conglomerate, in which nodules of all sizes of fresh serpentine are imbedded in a matrix of crushed serpentine. The edges of the dike are finely laminated and full of slickensides. West of the serpentine are dikes of diorite, dioritic conglomerate, strata of hornblende schist and hornblendic conglomerates, followed by felsite, jasper, and quartzose rocks. Then there is another dike of crushed serpentine, followed by fine diorites, and at some distance up the cañon by massive serpentine. This series of dikes is worthy of far more study than could be given at the time.

On the Round Valley road the shales extend up the side of the mountain to an elevation of 2,000 feet. Above the shales are dikes of serpentine so badly crushed as to be reduced to powder; alternating with these are hard, fine-grained rocks, jasper, petrosilex, pseudo-diorite, and feld-

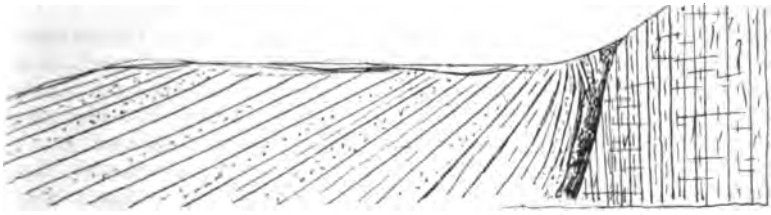


Fig. 6.

spathic rocks. Farther up the mountain are talcose and argillitic slates. These continue westward along the ridge for several miles without much change, except to become contorted and filled with bunches and veinlets of secondary quartz. These rocks form the summit of the Coast Range, and extend indefinitely westward. The most common strike is north and south. A fine view of the Cretaceous foothills is obtained from the high mountains. The strike of the strata is parallel to the line of upheaval, and owing to the different degrees of hardness there is a succession of valleys and mountains extending in the northwest and southeast direction, with abrupt escarpments to the southwest. A valley has generally been eroded at the western edge of the Cretaceous. On the south bank of Thome's Creek is a sandstone dike similar to those described by J. S. Diller. The Metamorphic Series has here a width of 18 miles east of the divide. The highest points of the divide reach an elevation of 7,000 feet.

In the edge of the mountains 1 mile north of Thome's Creek there is an outcrop of gray limestone similar to that farther north.

The shales south to Newville and beyond dip very steeply for 2 or 3 miles east of the serpentine, often as high as 75°. Four miles southwest of Newville the serpentine expands again to a width of over 2 miles, forming a long ridge projecting into the valley at a small angle. In it is a deposit of chrome iron in granular form. Bodies of diorite of varying appearance appear in the serpentine.

Fine specimens of the fossil aucella occur on Grindstone Creek. A mile south of the creek, and 3 miles west of Stony Creek, the shales rise to a height of 1,400 feet, and are terminated by a dike of serpentine not over 100 feet wide. Pearly talcose schists follow the serpentine for a few hundred feet, when there occurs another dike of serpentine. West of this schists and slates outcrop to the divide. A part of these are green schists, often crumpled and silicified, while the slates are often the jet black variety. So abundant is the quartz that the surface is often covered with the fragments. The strike is very irregular, but averages north 40° to 80° east. The hills are covered with dense brush up to an elevation of 3,000 feet, where the pine timber begins. The black slates are often finely cleavable in pieces of considerable size, and resemble those of the Mother Lode.

On Elk Creek, 4 miles west of Stony Creek, the shales come in contact with the black slates and green schists. The shales gradually increase in dip as the contact is approached, finally becoming vertical or reversed. The schists dip east 70° to 80°, strike north 20° to 30°. The change to the vertical green schists is abrupt. Fig. 6 illustrates this contact. Toward the crest, 5 miles away, they become more silicified. The clay at the contact has been formed by an upward movement of the meta-

morphic ridge, a condition noticed at several points farther south, and which to a certain degree obscures the non-conformity. This is undoubtedly the reason for the apparent conformity between aucella-bearing strata and the metamorphics of Mount Diablo, mentioned by Mr. Becker as a proof of the unity of the two formations. About 100 feet north of the creek a dike of serpentine begins and widens northward. It lies between the schists and the shales. The latter show the usual blackening and hardening near the contact, while in the cañon, where no serpentine is present, they are simply crushed. The serpentine, where not too much decayed, shows the usual foliated pyroxene crystals, and has associated with it fresh hornblendic rocks.

Serpentine appears again on Griscoe Creek, having a considerable width. It has associated with it dioritic rock and some jasper. West of these are the usual dark to pale green schists.

South of Griscoe Creek the metamorphics and serpentine take a more southeasterly course to and past Stony Creek. Between these points the shales also change in strike, and are bordered a part of the way by serpentines, and part by hard, dark, felsitic rocks. Strong salty and sulphurous springs are common in the shales through this section. A very fine contact between the shales and serpentine is shown on Stony Creek. The shales are much broken for 300 feet, but the stratification is obliterated, and they are distinctly metamorphosed for only 100 feet. They are largely serpentinized and filled with seams of carbonates, so much so that their original character has entirely disappeared. These secondary changes have in part obliterated the effects produced by the molten dike. Both the altered shale and the serpentine have been rendered fissile by pressure and movement along the walls of the dike. Several hundred feet from the contact the serpentine becomes massive and shows the usual foliated crystals. A quarter of a mile within the serpentine is a body of diorite. The relation of these bodies of diorite to the serpentine has not yet been investigated. They may be a differentiated portion of the base magma, or masses of unfused rock caught up in the intrusion. Three miles northeast of Stony Ford there is a vein-like deposit of lime in the serpentine, which is being quarried and burned. The serpentine ridge runs about a mile east of Stony Ford, and is inclosed in Cretaceous shale. For many miles north of the town a valley has been eroded between the shale and the serpentine. Parallel ranges of hills formed of coarse conglomerates lie farther east.

About Stony Ford there is a large area of good land, with plenty of water for irrigating. The eastern foothills of Mount St. John are covered with a reddish adobe soil, and underlaid by a dark basic rock, which seems to be an aphanitic variety of an old and greatly altered eruptive. This massive rock outcrops along the road to Fout's Springs for a distance of 4 miles. It is followed by dull red jasper, and that by serpentine. The latter rock is the southern continuation of a large body of the same composition which has been intruded into the basic rock on the eastern slope of Mount St. John. The serpentine is followed by pale green quartzose schists, talcose, and black finely cleavable slates, and sandstone, as far as the summit. In many places through the brushy hills below the timber line, the slates are only slightly metamorphosed, and might easily be taken for the Cretaceous if it were not for other considerations. There is not much silicification nor are the schists greatly crumpled. The strike is very irregular, east and west to north 60° west.

Along the ridge southeast of Fout's Springs, bunches of the dark aphanitic rock, similar to that north of Stony Creek, appear in the slates. The divide at the head of Mill Creek has an elevation of 6,000 feet. This elevation is kept up for 3 or 4 miles to the south, when the ridge turns easterly and sinking below the timber line, becomes covered with heavy brush. At the head of Mill Creek the rocks strike east and west, and show a slight amount of silicification. Coarse and fine sandstones abound, and also actinolite and glaucophane schists. This formation extends southerly for many miles into Lake County. The topography of Lake County can be studied to advantage from here. As far as one can see to the south and west, the county consists of parallel ridges. No intrusive rocks appear on the ridges at this point. Northward toward Snow Mountain there is much sandstone, and silicification becomes more prominent. Bunches of serpentine and green diorite occur near Fout's Springs; the former becomes very extensively developed northward along the eastern slope of Mount St. John. On the grade east of the springs there is a good exposure of black slates. These form the country rock in the vicinity of the springs. The serpentine is so greatly crushed along Stony Creek, north of the springs, as to present soft, greenish clay banks. No contact appears, but the serpentine is of course younger than the amygdaloidal eruptives forming Mount St. John.

Almost the only rock exposed along the cañon of Stony Creek for a number of miles is an amygdaloidal eruptive. The amygdules are generally small and occur through the rock in bands or layers, undoubtedly due to flowage. They consist of chlorite or calcite. Two miles up the cañon, at the very base of Mount St. John, the rock becomes a diorite porphyrite, with pale green feldspar crystals. In places it assumes a granular structure and appears like a diabase. Orbicular diorite appears in places. For a mile in the cañon the rock is a diorite tuff, whose origin is rather uncertain. The bedding is, as a rule, plainly visible, with a slight dip. However, it sometimes becomes compact and massive, and the pebbles are so nearly blended as to suggest other than a clastic origin. This diabase or diorite, as a part of it may be, probably forms the whole of St. John and the eastern and northern part of Snow Mountain. On the summit and western side of Snow Mountain there is said to be much red jasper. The two mountains are nearly of equal height, rising about 7,000 feet. They are the most prominent peaks in this portion of the Coast Range.

The geology about the head of Stony Creek is quite complex and of very great interest. All the foothill country south of Stony Ford consists of Cretaceous shale. A large body of serpentine begins in the high hills southwest of the town and extends in a southeasterly direction between the Cretaceous and the older series. It extends into, and forms the divide west of, Bear Valley. On the head of Little Stony Creek the metamorphics are highly altered, feldspathic and hornblendic schists and pseudo-diorites predominating. Bear Valley is one of a series which have been eroded at the contact of the Cretaceous with the serpentine. A line of sandstone and conglomerate hills divide the upper end of Bear Valley. The pebbles are chiefly jasper, quartz, and petrosilex. The dip varies from 40° to 70°. Serpentine outcrops at the eastern base of the divide between Bear Valley and Little Indian Valley. Up the grade it is succeeded by red argillaceous jasper and fresh diorite. Then for a mile across the summit only serpentine is seen. A short distance down

on the west, shaly slate is encountered. It strikes east and west and is less than 100 feet wide. It is followed by serpentine again, and that by soft shales, striking north and south, and a body of sandstone a quarter of a mile across. As a general thing the sandstone is not greatly metamorphosed. It is succeeded by more shale and then by serpentine, in which are argillitic masses, great and small, together with jaspers and flinty rocks, quartzites, and dike-like bodies of diorite and feldspathic rocks. Farther still toward the west the serpentine becomes so broken up by these bunches of rock, which become more metamorphosed, that it assumes the appearance of dikes winding and twisting through the metamorphic rocks. The serpentine is often green, often jet black, with a shining metallic luster, caused by the great pressure and movement to which it has been subjected. In many places there is an excellent opportunity to study contact phenomena. The sharp line of contact between the serpentine and metamorphics is always to be seen. On the hillside the serpentine has decayed away, leaving a sharp ridge of hard argillite exposed. In a gulch there rises a vertical cliff of argillitic rock; the serpentine has been eroded, leaving the smooth, hardened, and blackened surface. The serpentine has often been reduced to a powder. It is probable that this took place after the serpentinization. The metamorphics have lost their stratification and have been so crushed as to appear but slightly altered.

It would be very easy to confuse these slates and sandstones with the Cretaceous in Bear Valley; that is, judging simply from the amount of metamorphism; but I believe they belong to the older series, for no fossils were seen, though carefully looked for, and also because of their position, for 2 miles east in the serpentine are jaspers, which are known only in the Pre-Cretaceous rocks. The exceedingly metamorphosed and crystalline bunches in the serpentine probably belong to rocks of that class, which have been noted so often near the eastern edge of the older series, and which were already metamorphosed at the time of the serpentine eruption. These rocks, together with others of the Metamorphic Series, were broken in fragments by the intrusive magma, and enveloped by it. The small metamorphosing power of this basic magma is also to be noticed. I know of no more interesting spot in the whole Coast Range for the study of serpentine and its relation to the older series. The theory of the metamorphic origin of serpentine itself receives no support from the phenomena.

A little east of Stanton's, in Little Indian Valley, a body of the green quartzose schists appears in the serpentine. This is the rock traced continuously south from Bully Choop. The surface near this outcrop is covered with quartz from the small veins with which the schist is filled. The serpentine outcrops along the road nearly to Cache Creek, and seems to form the greater portion of the hills east of the creek, and south of Little Indian Valley.

The serpentine narrows to the north, and the divide 3 or 4 miles from Stanton's is formed of the metamorphic rocks. Pebbles of the green, wavy schists filled with quartz veins are numerous in the creek, which rises north of Little Indian Valley. Sandstone is the first rock found outcropping on Cache Creek; strike north 30° west, dip vertical. In it are dikes of a green eruptive. For several miles up to the mouth of Bartlett's Creek the rocks are chiefly slates and sandstones, striking north 40° to 60° west. The slates are usually finely cleavable, and can be

obtained in large slabs. Very often the slatiness has been destroyed by crushing, and flattened needle-like fragments result. This is particularly noticeable where the strike of the slate forms an angle with the line of upheaval. Of two layers side by side, one is undisturbed, the other crushed or twisted out of all semblance, or the undisturbed strata change in a few inches in the line of strike into the same condition. Green dikes become numerous, and at Allen's Springs a red mineralized stratum, with dikes adjoining, seems to show the effect of mineral waters.

North of Allen's Springs, the divide between Cache Creek and Bartlett's Creek contains dikes of diorite and serpentine. The latter forms a series of bunchy dikes extending in a northwest direction past Bartlett's Springs. The elevation of the springs is 2,100 feet. The green dikes sometimes assume an amygdaloidal character, showing their intrusive origin. It is often difficult to distinguish these dikes from the green metamorphic schists, when the amygdaloidal character is absent.

Near Allen's Springs is a stratum of conglomerates interbedded with the slates. The pebbles are chiefly quartz of different kinds; the dip is vertical. Slate forms most of the rock at Bartlett's. Sandstone predominates in the mountains toward Clear Lake. There are bunches of diorite and serpentine about Bartlett's which undoubtedly have some connection with the springs.

The formation is much the same for many miles northwest of Bartlett's, except that in places it is more silicious. There are some glaucophane schists and small patches of the amygdaloidal green dikes. Serpentine also appears in places along the hills south of the North Fork of Cache Creek. On Eel River, 5 miles from Bartlett's, there is a large body of red jasper schists filled with secondary quartz veins; also green chloritic and crumpled schists. This shows that the greatest silicification is not confined to the higher ranges. On the head of the North Fork of Cache Creek a body of soft, black shales is met again. They are so greatly crushed that the stratification is destroyed. There is no question but that these as well as other occurrences are an integral part of the older series, but the crushing they have undergone has given them the appearance of less metamorphism. In fact, it seems that with almost any degree of metamorphism, slates maintain much the same appearance, and thus in the orographic movements the argillaceous rocks are far more apt to be crushed than the more quartzose ones.

The serpentine on the head of Eel River is crushed to a green clay, or shining black shales. At Crabtree Springs the serpentine is exposed in the bed of the creek, with argillaceous shale on both sides. The springs come up at the contact as well as in the serpentine. There is an immense amount of carbonic acid gas bubbling up through the water of the creek and that which flows out of the hillside. The noise of the escaping gas can be heard some distance. Birds and small animals are often killed on coming down to the creek to drink. Iron, soda, and sulphur springs lie close together. Quicksilver is reported as having been found here. These are among the most wonderful and valuable springs in Lake County, but they have never been opened to the public. At present they are difficult of access. White jaspery quartzites outcrop near the trail. They are full of very minute quartz veinlets. The silicification has not affected the black slates to so great a degree, perhaps because they were crushed rather than fractured, and consequently did not offer a passage to the silicifying liquids.

It appears that all the springs of this section are situated nearly in a line extending northwest from Hough's Springs, and near or on the line of the serpentine intrusives.

Sandstone is the prevailing rock exposed along the north side of the mountain between Bartlett's Springs and Upper Lake. The strike and dip are seldom noticeable, but the rocks are cut up by jointing planes. More slates appear on the south side of the range, and down to the Toll House form the larger part of the rock; they generally dip at a high angle to the north, strike with the mountain range, northwest and southeast. The height of the range is 4,000 feet. A mile and a half above the Toll House the black slates are crushed to a mass, into which the broken sandstone strata have been squeezed, so that fragments lie wholly inclosed in the black clayey mass. The shales also contain small bodies of metamorphic limestone. No intrusive rock, except a small area of serpentine near the summit, and a body of green dioritic character on the southern slope, was seen. Actinolite in finely crystallized masses occurs on the summit. The ridge south of Clover Creek, extending toward Upper Lake, is formed largely of jasper. Several bodies of serpentine occur in it a mile east of Upper Lake. A ridge of soft sandstone begins a mile northwest of Upper Lake, and extends northwesterly for about 10 miles between Middle Creek and Bachelor Valley. It rises to perhaps 1,000 feet above Clear Lake. The strata are thick bedded and almost level, and are underlaid by the argillites of the older series, which replace the sandstone on the northwest. It contains no fossils, but from its resemblance to the fossiliferous Chico-Tejon sandstones near Lower Lake, it is judged to be of that period. Banded jaspers are abundant along the north side of Middle Creek. They are often wavy and filled with secondary seams of quartz.

An artesian belt extends north and south through Upper Lake. It is about 5 miles long and three fourths of a mile wide. Water is obtained at a depth of 60 to 70 feet, and will rise 20 feet above the surface. It is found under a bed of clay, or in some cases cemented gravel. The water-bearing strata extend up Middle Creek, the gradual rise giving the pressure. No surface water flows in this or Clover Creek. The basin is quite limited, for when new wells are put down the others are weakened.

The rocks along the northern side of Bachelor Valley are slates, which have been much crushed. Toward the Blue Lakes sandstone predominates.

The Blue Lakes are in a deep, narrow cañon, and almost on a level with Clear Lake, with which they must have been once connected, either by Tule Lake or Scott Valley. The latter runs northwest from a point 2 miles west of Lakeport, and is separated from the lake by low clay and gravel hills. The lakes are located in what once must have been the outlet of Clear Lake when it emptied toward the west. The lakes have been formed by the filling up of this old cañon from side gulches. This fact is finely illustrated at the Blue Lakes Hotel, where the two main lakes are separated by a body of detritus from cañons on opposite sides. The lakes are said to be over 200 feet deep. A slight elevation of the mountains on the west must have been sufficient to turn the lake eastward into Cache Creek.

Nearly all the rocks exposed through Scott Valley are sandstones, often shaly and soft, with no distinct stratification. The surface appear-

ance is, however, no criterion, as the rocks are softened to a considerable depth. Fresh pieces are quite hard and compact. Many amygdaloidal intrusives, somewhat similar to those about Bartlett's, are scattered through the hills about Scott Valley. Some are porphyritic with feldspar, and others contain large or very minute amygdules.

Between Upper Lake and Lakeport there is a large body of serpentine. Slates, with the usual strike and vertical dip, were also seen. Between Upper Lake and Morrison's the rocks are exposed in places nearly to the water's edge. They seem to be chiefly sandstones, with jasper higher on the ridge. A mile east of Upper Lake there is a cropping of coarse diorite, containing hornblende crystals a half inch in diameter. This extends east for some distance, but is generally fine grained and might easily be taken for a metamorphic sandstone. As a matter of fact, the sandstone shows no tendency to become crystalline. The valley of Clear Lake has been eroded in the sandstone and shale of the older series where they were least metamorphosed, and consequently more easily washed away.

A careful search was made for fossils, a mile and a half east of Morrison's, where W. A. Goodyear had mentioned seeing some, but nothing was found, save some small impressions of plant stems, one eighth of an inch in diameter, straight and jointed. The sandstone and shale do not dip at a high angle, in places being nearly level, and to all appearances are but slightly metamorphosed.

Quicksilver has been found on the lake shore near Morrison's, and two tunnels run. The deposit seems to have no relation to intrusive rocks, unless one near the entrance to the tunnel be a greatly decomposed diorite. It is filled with calcite seams. From this point the new toll road was followed to the summit, and from there a road leads to High Valley. The eastern end of the valley is covered with basalt, which extends east to the North Fork of Cache Creek. Basalt occurs northeast of the Sulphur Bank, and also at the mines. Here it has been decomposed over a large area near the water's edge by solfataric action. In places the decomposition is complete; in others it has operated only along cracks or seams in the basalt, leaving large rounded bowlders of the fresh rock with concentric shells formed of the whitish secondary product. Sulphur and cinnabar have been deposited in the decomposed portions. Where decomposition has been complete amorphous silica is the most important residuary product. The cavities of the basalt, where unaltered, contain more or less of opaline quartz, and bunches of acicular crystals of aragonite. The work here now is confined exclusively to the surface. Great pits and trenches have been dug as the quicksilver has been traced from point to point in the decomposed portions of the basalt. It is supposed that the deposit of quicksilver is still going on, and, on many accounts, it is a very interesting place for the mineralogist.

Big Valley is formed by Quaternary deposits, formerly the bed of Clear Lake. It covers the region about the lake between Kelsey and Adobe Creeks. At Kelseyville is a little knoll several hundred feet across, out of which illuminating gas has seeped. A well was bored here to a depth of 160 feet, passing through blue clay and some gravel. On striking sandstone an abundant flow of gas and mineral water was met. At first the force was so great that the water rose 15 feet above the top of a 20-foot pipe. The water is evidently brought up by the gas. Wells have been bored to a depth of 400 feet at a distance of a mile north and west, but nothing of this kind was found.

The Quaternary clays, hardened almost to a shale, outcrop in the hills between Kelsey and Adobe Creeks. They reach an elevation of 500 feet above the lake, and apparently overlie the obsidian tufas. The Metamorphic Series outcrops about a mile east of Highland Springs. It consists of massive sandstone, banded quartzite, and jasper. Farther south serpentine outcrops between Kelsey and Adobe Creeks. Beautifully banded obsidian outcrops along the road to Cobb Valley for a distance of 4 miles, reaching nearly to the summit. White ash is often interstratified with it. Slaty lavas form the top of the mountain, which has an elevation of 3,000 feet. Serpentine is met on the southern slope of the mountain. This rock outcrops for many miles through the hills east of Cobb Valley, reaching in its southern extension nearly to Middletown. A large part of it has been reduced to a clayey powder, in which rest nodules of the massive rock. Volcanic rocks cover Mount Cobb and extend down to the road on the divide northwest of Middletown. Metamorphic sandstones, greatly crushed, outcrop along the road to Middletown. They are jointed and crushed. There is a large extent of serpentine south of the town in the vicinity of the quicksilver mines. The rocks exposed along the road which leads up to the Great Western Mine belong to the older series, and are considerably metamorphosed. Glaucophane schists, banded quartzose rocks, and green schists predominate. The stratification is generally destroyed, but when present it is quite flat; dip varies from northwest to southwest. The mine is located on the contact of greenish quartzose schists with silicified serpentine. The ore occurs on flinty opaline strata, which probably belong to the Metamorphic Series, and also in seams in the silicified serpentine. The serpentine is silicified to quite a distance, and veins of opaline matter run through it beyond where it is completely altered. The mountain range forming the western boundary of the county consists of the usual jasper and sandstone, with some hornblende schist.

The Bradford Mine is located on a deposit which occurs chiefly at the contact of silicified shale and serpentine. The ore occurs in part impregnating a black to light-colored opaline sinter, which seems to represent the total replacement of the serpentine; and in part the impregnation of the silicified foot wall, which was originally an argillite. A wedge-shaped dike of serpentine lies at the northern end of the workings and divides the ore deposit. Serpentine is met also at the southern end. Between these points the ore occurs in silicified metamorphic rocks. The ore body pitches to the southeast, the mineralized stratum to the east. The body of ore worked has a thickness of 50 feet at the widest part, and a length of 300 feet. The main deposit lies on the foot wall or in the form of veins running down vertically or dipping toward it. The ore occurs, as in other mines, in seams in the crushed gangue, though it is sometimes scattered through the hard, massive portions, and then must have been deposited at the same time as the silica in which it is inclosed. Two periods of deposition are thus represented. They are separated by a time of movement and crushing in the vein. In places there is found a considerable amount of native mercury and some sulphur. North of the workings is another ore body, 90 feet long and 20 feet thick. Calcite and quartz seams run through the rock and into the foot wall. Much iron pyrite is present in the mine, and in the vicinity of the larger masses the workings are much warmer, owing to the oxidation. The pyrite coats the deposits of the other

minerals, and seems to have been the last substance deposited in any quantity.

An old mine across the creek from the Bradford is located in sandstone, which is to be seen on the dump. Dr. Becker speaks of it as unmetamorphosed and representative of the Cretaceous, but it has undoubtedly become soft through decay and belongs to the older series.

Serpentine is the chief rock exposed along the road for 2 miles above the Bradford Mine. The hills on the east are formed of the same rock until the volcanic deposits hide it from observation. The serpentine by the road incloses bunches and dike-like masses of diorite of varying degrees of crystallization, and also seems of a dark aphanitic material, which may simply be finer portions of the serpentine. The serpentine is very much decayed, but instead of being crushed to a clay, it shows a jointed structure, breaking up into small angular fragments. It decays on the surface to a yellowish mass, very strongly resembling a soft sandstone. This of course is a resemblance merely, which has deceived many with regard to the origin of serpentine. The diorite does not seem to be altered sandstone, for no transition has been observed. It belongs either to dikes intruded into the serpentine, or to deep-seated crystalline rocks brought to the surface with the melted magma. The serpentine has never been noticed to have any great metamorphosing power.

Thick deposits of white volcanic ash cover the ridge toward the Oat Hill Mines. Two miles west of the mines it is replaced by andesite and basalt. The bedrock, wherever exposed, is a soft, light-colored sandstone, and shale. Where it is not capped by lava it shows a dip of 30° to 40° north, strike east and west.

The Oat Hill Mines are located in a body of soft sandstone, which was first noticed 2 miles to the west. It extends nearly to Pope Valley and has a width of about a mile. On the east it blends gradually into metamorphic sandstone. This is clearly shown on the western slope of the hill lying east of the works. North of the lava-capped ridge are hard argillites, turning to green and red jasper, filled with minute veinlets of quartz. The black argillites are also somewhat silicified. The strata dip at a high angle to the north, and a mile away to the northeast they are followed by granular serpentine. In places the serpentine has undergone such pressure, accompanied by movement, that it has become a mass of tough, welded fibers. Coarse hornblendic rocks are associated with the serpentine. All the observations made about the Oat Hill Mines show conclusively that these soft sandstones belong to the older series.

For some unknown reason this strip of country, of which the Oat Hill Mines are about the center, has escaped the prevailing metamorphism. No signs of any intrusive rock are to be found in any of the workings of the mines, and the occurrence of extensive cinnabar deposits wholly in sandstone and shale is an anomaly. The veins run generally about north 22° west, dip to the northeast. Three veins are worked in the Eureka Mine, one of which runs southwest. The ore occurs as veins and impregnations in the sandstones. Wherever the ore occurs in the form of defined veins, it is usually associated with or has a gangue of hard flinty rock, not opaline, as is usually the case. This hard stratum lies on the foot wall, but separated from it at times by a heavy layer of clay. However, this tough layer of clay is more often found on the hanging wall. Owing to this clay on the hanging wall, the large veins

and chief impregnations often extend out into the foot wall. Outside of the clay on the hanging wall, no mineralization has taken place. In places the main vein reaches a width of 80 feet. It consists of the impregnation of the soft sandstone. Often the ore is visible only when the rock is scraped, thus crushing the crystals of cinnabar and producing a red streak. This is the test employed in the mine to determine whether the ore is present or not. There are also seams of granular sand, richly impregnated with cinnabar. It is probable that the water which once circulated through the seams abstracted the clay, leaving the clean sand, for it has been noticed that in many places on the hillside, wherever there are signs of solfataric action, just below are deposits of fine clay. One ore shoot has been found to be 500 feet long; the ore running southwest over 300 feet, and very regular. Wherever the sandstone is very hard, the ore is found in the comparatively narrow seams. When there is not much clayey matter, and the sandstones are soft, they are impregnated for a great width. No native sulphur is found here. In the tunnels not worked for several years there forms a heavy deposit of epsomite in fibrous aggregates It is 4 inches deep in places on the bottom of the tunnel. The north ends of the veins in the Eureka claim show a tendency to swing toward the west and southwest. A breccia of sandstone fragments, mixed with clay, is often found. The strata are very finely banded and somewhat silicified in places. Small quartz seams appear at times, but show no relation to the ore deposits. Shaly sandstones appear near the northern base of the mountain. They are but slightly altered and dip in various directions.

Near the eastern end of the Calloyami ranch appears tawny, heavy-bedded sandstone. It undoubtedly belongs to the Chico-Tejon series. Northward, along the road to Guenoc, this sandstone appears in mass resting on the serpentine, which forms a line of hills between the Guenoc and Calloyami ranches. It is also extensively developed along Seigler Creek. They are so thick bedded that the dip is quite indistinct, but it is probably southwest at a small angle. The sandstone forms a line of hills north of Harbin Springs. A little farther toward Guenoc, but not directly in contact with the Chico, are shales and hard feldspathic sandstones belonging to the older series; dip east 15° to 20°. These are followed by serpentine. Putah Creek flows out of the valley through a deep cañon formed of stratified basalt cliffs. These extend nearly to the mouth of Soda Creek, so that no contact between the Cretaceous and the older rocks could be found. Some float gold is found in the hills southeast of Guenoc, but its source has not been found. Chico sandstone underlies much of the volcanic country between Seigler Creek and Lower Lake.

The valley of Soda Creek is bounded on the west by an abrupt tableland of basalt. Three miles from Lower Lake soft sandstones appear and cover the country to the town, except a small outcrop of the metamorphics 2 miles southeast. The latter rocks consist of hard green schists. Though no actual contact was observed, on account of the great amount of soil, yet there is not the slightest doubt of an unconformability. About the head of Soda Creek these Chico-Tejon sandstones overlie the Knoxville shales, but whether conformably or not is uncertain. The sandstone extends 4 miles north of Cache Creek. Two miles below Lower Lake the creek has cut a narrow cañon through this formation. The strike is north 10° west, dip 70° east. This high degree of

dip makes it more than ever uncertain what its relation is to the Knoxville series. If it is unconformable with the Knoxville there has been a very great upheaval since the Cretaceous. Although there has not yet been found positively an unconformity between the Chico and the Knoxville, yet from the very fact that the serpentine has been intruded through the Knoxville, but not through the Chico, shows that there must be one. From the relative amount of disturbance exhibited by the Chico and Knoxville beds, it is probable that the latter was intruded and somewhat tilted before the deposition of the Chico. Although these formations are apparently conformable in Tehama County, and have been stated to be so by J. S. Diller, yet the Chico lies on the eastern edge of the great Cretaceous deposits, which are fully 5 miles thick, and being so far from the mountains where the elevation and extrusion of the serpentine took place, the Horsetown shales on which they were afterward deposited did not experience the tilting of the Knoxville beds, which lay against the flanks of the mountains. Hence, they were deposited apparently conformable, though a hiátus really exists. The Chico sandstone appears along the road to Seigler Springs. It is often tilted at a high angle, at times vertical, with varying strike. Between this and the basalt forming the higher hills is a small outcrop of jasper and hard chloritic and argillaceous schists. The rocks are jointed and contain vein-like quartz deposits.

A large number of fossils are found in the Chico sandstones about Lower Lake. The sandstones outcrop along the road to Knoxville for many miles, particularly prominent in the ridges between the road and Cache Creek. Three miles east of Lower Lake small patches of a green metamorphic rock project through the Cretaceous. Five miles east a silicified dike of serpentine appears on the hills on the north, and extends southeast past the Baker Mine. It has been altered to a black shining glass, containing green patches of the original rock. The Baker Mine is located on this dike. The cinnabar is found as an impregnation in a crushed zone running north 10° west, and having a width of 8 to 20 feet. It is found over a length of 3,000 feet. The ore deposit is almost wholly an impregnation. From the main body little seams of the ore extend out through lines of fracture in the serpentine. The dike is inclosed in clay derived from the crushing of the Cretaceous shales. The ore deposit pitches northeast 30°. In many places the cinnabar is intimately mixed with iron pyrites, or coat seams of the same mineral.

One mile down the road, on the head of Soda Creek, is a very interesting exposure. The metamorphic rocks, consisting of hard, massive, but jointed sandstone, outcrop in a high bluff south of the creek. It breaks in small angular fragments and is seamed with quartz. A dike of aphanitic diorite has been intruded into the sandstone. Forming the north side of the creek, but hidden in the bottom by a slide of Chico sandstone bowlders from above, is a cropping of the Knoxville shales and fine sandstone. They strike parallel to the junction, a little west of north, and dip to the east at an angle of 30°. They are wholly unaltered, and carry well-preserved specimens of aucella (Fig. 7). Other specimens of aucella were found along the road a short distance east. This outcrop of the Metamorphic Series extends toward the southeast; how far, is not known.

The sandstones on the top of the hill a quarter of a mile north dip and strike about the same as the Knoxville, and half a mile east along

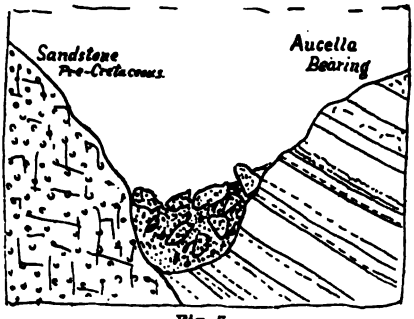


Fig. 7.

the road they replace the Knoxville shales. The change is indicated by the color of the soil, for the outcrops are not good. It is not certain what the relation of the two formations here is, but they are thought to be unconformable. Chico sandstone outcrops along the ridge between Morgan Valley and the head of Soda Creek, dipping 10° to 30° northeast. With the sandstones are some shales and concretions. South of Morgan Valley are large, flat hills, capped with stratified basalt. It is very fine grained, jet black, and gives a ringing sound when struck. Three miles east of Morgan Valley is an impure limestone, containing fossils, probably Chico. Between this point and Knoxville is a series of little valleys, with a high serpentine ridge on the north between them and Cache Creek. Serpentine also appears in the hills south, extending in a southeast direction. Associated with it are some bodies of metamorphic rocks, jasper, and other characteristic schists. The Chico beds extend from Morgan Valley about 4 miles southeast between these ridges.

About 4 miles northwest of Knoxville there is a very puzzling mixture of serpentine, metamorphic rocks, and Cretaceous shale. The road passes in a southeasterly direction for a mile through some small valleys eroded in a narrow stratum of shale, dipping northeast, which evidently belongs to the Knoxville beds. South of the road is a long, narrow strip of massive metamorphic rocks and schists; while on the north is serpentine, containing numerous bunches of massive schistose, semi-crystalline rocks.

From Knoxville north to the Reed Mine and beyond the valleys have been eroded at the contact of the serpentine with the Cretaceous shale. East of the Reed Mine is one small area of serpentine, but the high parallel ridges between this point and Capay Valley are formed wholly of Cretaceous sandstone and shale, dipping to the northeast at a high angle. The Cretaceous shales stand vertical in the bed of North Fork of Davis Creek. The ore of the Reed Mine lies in a zone of crushed and silicified serpentine. The ore occurs in vein form, and in bunches and impregnations, very similar to the deposits of the other mines with similar walls. At the open cut above the old works a body of fine ground diorite rises in a high-pointed peak on the west side of the vein. It extends northward in dike form, appearing on the northeast or hanging wall side in several detached outcrops. The hanging wall in places is a dark, jaspery rock. A short distance east is a stratum of conglomerate, interbedded with the shale. The pebbles are quartzose, and are filled with minute quartz veinlets. This is another indication that

the metamorphism of the older rocks took place before the deposition of the lowest Cretaceous; for these pebbles must have been derived from that formation. The dikes of diorite are well defined. They are surrounded by heavy clay seams and are of a lenticular form. They show no tendency to blend, either into the serpentine or the unmetamorphosed rocks. Up the creek a quarter of a mile is a bunchy dike of diorite or diabase wholly inclosed in the shale. If this has been intruded into the shale it was so small that no metamorphism was produced. I do not see how these crystalline masses can be looked upon as anything but intrusives. There is certainly no blending into the surrounding rocks. On the hill above the mine is a deposit of a white aluminous or magnesian material. It is said to be traceable for 4 miles.

Numerous pebbles of hornblende granite are found between Knoxville and the Reed Mine. As granite has never been found in place in this portion of the Coast Range, it must have been derived from some locality now covered. The pebbles are probably derived from the Knoxville conglomerates. Many pieces of green and actinolite schists are found in Davis Creek. They are probably derived from the bunches of metamorphic rock inclosed in the serpentine. The serpentine extends in a southwest direction from Knoxville to Soda Creek, a distance of 7 or 8 miles, and toward the south for a greater distance. It contains a very interesting series of rocks of various kinds, which are particularly abundant along the ridge west and southwest of Knoxville. Among these are massive crystalline rocks, slates, and schists. From this occurrence Dr. Becker has developed his theory of the origin of serpentine from sandstone metasomatic processes. The question as to how these masses of such totally different character became inclosed in the serpentine is a puzzling one, but the theory of the development of serpentine from them has not the slightest proof, as far as my observation has gone.

A body of Cretaceous shale appears in a gulch, a half mile west of the Redington Mine. It is a half mile long and nearly inclosed in the serpentine, but totally unaltered. West of this is the main body of serpentine. It is filled with numerous nodules and kidney-shaped masses of argillaceous and crystalline dioritic rocks. The serpentine is generally reduced to a shaly mass, in which are imbedded not only the rocks just mentioned, but also hard nodules of massive serpentine. There has been great movement in the serpentine, often reducing the rock to a light-colored green clay. The lamination is very sinuous, bending and winding in every direction and around the nodules. The foreign bodies included in the serpentine show a very diverse appearance. The more stratified and slaty ones are long and narrow, sometimes 100 feet in greatest length. When of larger size they project up many feet above the serpentine. All of these observed were highly metamorphosed, save in one case, where a small mass of argillaceous rock occurred 3 to 4 feet across, which was almost wholly unaltered, though reduced to a splintery aggregate by pressure. All of these masses in the serpentine are arranged with their long axes parallel to the trend of the mountain ranges, northwest and southeast. These bodies, both large and small, though sharply defined from the serpentine and surrounded by slickensides, show a bounding surface, from a half to one and a half inches thick, of hardened serpentine, with a small amount of rock material intimately blended with it; then with a comparatively sharp boundary the unaltered portion of the rock (usually diorite) begins. This dark,

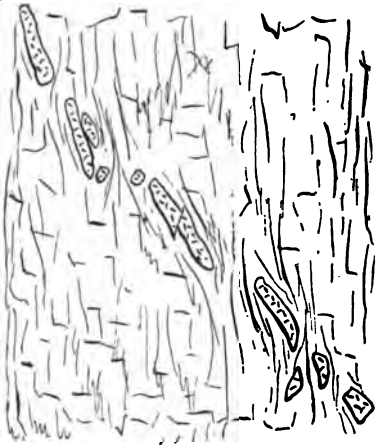


Fig. 8.

serpentinous outer surface is often finely polished and grooved like the walls of a fissure. The appearance is exactly what it would be if portions of deep-seated metamorphic rocks, more crystalline than those near the surface, were broken off, enveloped in the magma, elongated often on account of the tendency to schistose structure, and rendered kidney-shaped by the rounding of the corners, and slightly fused or permeated by the peridotitic material. Then at the time of decomposition to serpentine, alteration went on as deep as that material had affected the rock. When the earth movements began, the separation around this hard central core took place on the line of pure serpentine. Outside of this line the latter was crushed, and the core resting in a soft matrix remained, and was moved about as a whole, and polished. A very fine example of this is shown on Hunting Creek, where a great mass has tumbled down from the side of the cañon. It is 14 feet square and 6 feet thick, and highly polished on at least four sides. It is probable that some of these bunchy outcrops have been intruded into the serpentine, for several of the larger ones were seen to be continuous downward to the bottom of the cañon, and yet the greater portion are perfect nodules, and entirely surrounded by serpentine. It is unquestionably a fact that many of them have been placed in the serpentine by the same forces to which the bodies of metamorphic slate owe their position. Appearances indicate that some of the nodular masses appearing near together may represent dikes broken by the serpentine during movements within its mass. Bodies of this character are exposed in the cañon of Hunting Creek, and also in line across the hills near by. The larger dikes on this creek have a faintly porphyritic structure. Near one of the large ones are detached pieces of fine-grained diorite, extending in line diagonally up the side of the cañon. Several hundred feet farther east is a large dike, which has apparently split off vertically in layers, giving rise to elongated masses, sometimes wholly inclosed by serpentine. The latter rock is partly jointed and partly crushed to powder. Still farther up the cañon are two narrow and irregular, but continuous dikes, presenting every appearance of having been squeezed into the serpentine. Fig. 8 represents a string of the dioritic bodies on

the north side of the cañon. Here it is evident that the pieces were once continuous. The longer axes are parallel, and they are nearly in line. For several hundred feet above this point the serpentine has been reduced to a powder, with nodules of the massive rock remaining. For miles the serpentine is very generally crushed, producing a jointed structure more often, perhaps, than clay. It shows almost always traces of foliated pyroxene crystals.

If the nodular masses were remnants of a preëxisting rock largely reduced to serpentine, the transition would be more gradual, and the whole rock mass more or less permeated. It is not possible that such small, sharply defined bodies of metamorphic rock could exist, as they do, under such conditions. A very interesting serpentine bowlder was found on the ridge above Knoxville. It lay in a mass of shaly serpentine, and was surrounded by a hard shell, concentrically colored with dark bands. It has a lighter colored and softer interior, intersected with dark branching seams, resembling serpentine undergoing atmospheric decay. The hard shell must be due to pressure.

The valley of Jericho Creek lies in shale and sandstone, probably Cretaceous; strike north 70° east, dip vertical, or nearly so.

The ores of the Redington Mine are found in silicified serpentine, at the contact with shales. A heavy clay seam lies between the deposit and the shale, and cuts off the ore in that direction. The best ore is found next to the clay, and spreads out to varying distances in the cracks and little seams of the crushed opaline mass.

The unaltered shales join without any transition the serpentine and diorite, which forms much of the ridge extending northwest to the Manhattan Mine. The latter rocks are very irregularly disposed. Hard, silicious slates are found in the serpentine. They cleave in large slabs, and in every way closely resemble the older series. The hard bodies of diorite or diabase rise above the serpentine in high, projecting peaks. For a distance of more than a mile along the Manhattan claims, the amount of opalized and chalcedonic quartz is enormous. It is several hundred feet in width in places and is bordered by silicified shales. The ore is partly in the opal and partly in the slate. Formerly solfataric action must have been almost continuous along this line. The silicified shale is probably an altered portion of the Knoxville beds. Bordering the silicified rock on the west is a considerable width of exceedingly crushed and decomposed serpentine, sometimes hardly recognizable as such. In this are innumerable bowlders and elongated nodules of a rock whose original composition can hardly be made out, though it is evident that feldspar formed an important ingredient. Other nodules are formed of hard, well-characterized serpentine. Some have a narrow serpentine border, while others are very sharply defined. The nodules of dark diorite are somewhat serpentinized, but those in the massive serpentine adjoining on the west are quite fresh. This massive serpentine is full of foliated pyroxene crystals. It is possible that the crushed rock was not originally serpentine, but similar in composition to the nodules. Thermal and dynamic action has so affected the rocks about the Manhattan Mine, that their real relations are obscure. I could not see the slightest reason, however, for believing that the serpentines have resulted from the alteration of rocks of the Metamorphic Series. The field relations existing about Knoxville gave to Dr. Becker his strongest proofs for the metasomatic origin of serpentine.

The bodies of slate schist and dark dioritic rocks extend in a northwest and southeast direction for several miles each way from the Manhattan Mine. This line of inclusions must represent a Pre-Cretaceous ridge, broken into fragments at the time of the intrusion of the serpentine, and brought up with it.

Former springs have deposited large beds of granular tufa at two spots west of the workings of the Manhattan Mine. Seams running through this tufa have been found rich in cinnabar. There are also thin vein-like deposits of a very beautiful glassy sinter.

The great body of serpentine and associated rocks continues in a southerly direction west of Eticura Creek, and forms the ridge west of Beryessa Valley. The width of this ridge, where Pope Creek cuts through it, is about 5 miles. No great bodies of serpentine were met until the western slope was reached, yet the metamorphic rocks and old intrusives forming the greater portion of the ridge are penetrated by a perfect network of serpentine dikes. The metamorphic rocks consist of jasper, seamed with secondary quartz, silicified slates, and immense masses of green rocks, divided between schists and massive diorites. Coarse diorites and white feldspathic dikes also occur, together with some hornblende schist. The amount of crushing exhibited by the rocks forming this ridge as they are exposed along Pope Creek is tremendous. Nearly all the serpentine dikes are reduced to a shaly mass or to powder. The argillitic rocks are also crushed to a clay shale, and seldom show cleavage or bedding planes.

From Knoxville southward it is probable that the amount of metamorphic rock increases until it culminates in this ridge.

At the lower end of Pope Valley occur slates and fine-grained sandstones, showing no signs of crushing, and dipping south at 10° to 20° from a great mass of diorite. Although no fossils were seen the rocks have the characteristics of the Knoxville beds, and are probably of that age, though somewhat more metamorphosed. No contact is seen between these beds and the older series (a thousand feet intervening), but the sudden change from diorites, crushed argillites, and jaspers, with secondary silicification, to those comparatively unaltered rocks, is indicative of the geological break. A half mile southwest they strike north and south, dip at a high angle to the west. These shales underlie Pope Valley, extending to the mountains on every hand. They extend but a little distance west of Ætna Springs. At the springs is a silicious mineralized vein formerly worked for quicksilver. This may be an altered serpentine dike, but no trace of fresh serpentine is to be seen. A hard sandstone, probably Pre-Cretaceous, outcrops in the bed of the creek just above the springs.

The Ætna Mines are interesting, on account of the great irregularity of the silicified serpentine and sandstone, and the presence of basalt as a wall rock in portions of the workings. The sandstone closely resembles that at Oat Hill. It can be traced over nearly all the distance between the two mines, and southeasterly in the mountains west of Pope Valley, where the lava does not cover it. One of the ore deposits at the Ætna Mines occurs in sandstone, others in the opaline brecciated matter on the contact with serpentine. The ore bodies, as a whole, are irregular, sandstone being often met in the deeper workings, when the surface consists of silicified serpentine. Iron and copper pyrites are present, also a reddish hydrocarbon, described from this mine as a new mineral.

illuminating gas is also found here in one of the workings. North of the Ætna Mines, on the southern side of James Creek, is an outcrop of hard jaspery rock, so filled with secondary quartz that it forms half of the rock. The cañon of James Creek shows a very interesting series of rocks for a distance of 2 miles above where it opens out into Pope Valley. Beginning opposite the Ætna Mines there crop, first, in the bed of the creek soft shaly sandstones, dipping at times west, at others north. Then come massive, fine-grained diorites, with dikes of purplish rock, probably an old eruptive, greatly altered and seamed with quartz, and in one place distinctly amygdaloidal. Below this are several strata of diorite conglomerates, also probably eruptive. Almost all the pebbles are amygdaloidal. Diorite forms the principal rock for nearly a mile. A crushed slate outcrops on the north bank of the creek, dipping at a small angle away from the diorite. Below the diorite is about half a mile of green quartzose rocks, very wavy, and filled with quartz veinlets; thus resembling the silicified rocks of the Coast Range from Shasta County south. Still farther down the cañon are green hornblende, glaucophane, and dioritic schists; strike northwesterly at varying angles. Serpentine outcrops on the northern side of the creek for some distance, finally extending across the creek in a narrow dike and containing hornblende pebbles. A silicified serpentine dike, 300 feet wide, crosses the cañon near its mouth. In this are several masses of hard hornblendic schist, with a sharply defined contact. Below the serpentine, which is somewhat mineralized on its eastern edge, there appears the wholly unaltered, but greatly crushed, Knoxville shales. They are apparently wholly unmetamorphosed by the serpentine. This is due, perhaps, to the impenetrability of a heavy clay seam which separates the shales from the serpentine. The shales dip to the northeast, though nearly vertical in places, and a mile east on Pope Creek carry the fossil aucella. On the northeast the shales are terminated by a great serpentine ridge, which extends toward Knoxville. It is utterly inconceivable how such a sudden change could be possible in strata affected by regional metamorphism. This cañon is a very interesting one, on account of its showing how much intrusive rock there often is associated with the Metamorphic Series, and the nature of which would scarcely be suspected, except when the surface decay has been worn away, as in the rocky cañons. The diorites and the hornblendic schists very closely resemble the nodular or elliptical bodies inclosed in the serpentine near Knoxville. Indeed, the presence of small fragments of the hornblendic schists in the serpentine in the cañon of James Creek is a good illustration of the probable manner of the occurrence of those near Knoxville.

A further examination showed that sandstones and shales, probably identical with those at the Ætna and Oat Hill Mines, underlie the western side of Pope Valley. They are often quite flat. Soil covers the contact with the Knoxville, which forms the central and eastern portion of the valley, and sends an arm westward to the Ætna Springs. The metamorphism of these yellow sandstones is so slight that it is very easy to mistake them for Knoxville. However, in their color, cleavage, and other characters they are wholly different from any known Knoxville strata. They are the only rock seen in the mountains southwest of the valley till the volcanic tuffs are reached. The volcanic rock, which is largely a tuff, covers the ridge to a depth of 300 to 400 feet, and extends down the western side nearly to St. Helena. Soft, light-colored clays are

seen underlying it on the western slope. They probably belong to the Quaternary period.

The road between St. Helena and Beryessa Valley gives a very interesting cross-section of the mountains. The first rock met on Moon's Creek is volcanic. Serpentine then outcrops along the creek, while the volcanic is confined to the hills. The serpentine dike is a mile wide. It is followed by sandstones dipping vertically, strike north and south. For 6 or 7 miles sandstone and shale are the only rocks along the road. They are not greatly altered, and often lie quite flat. Toward the summit of the divide they are more altered, showing silicification, quartz veining, and in one spot a pearly hydro-mica schist, containing some garnets. The ridge west of the southern end of Chiles Valley shows many dikes of serpentine scattered over a width of half a mile. They have been reduced to a shaly mass, in which are hard nodules of the fresh rock. It also contains bodies of fresh diorite with a thin serpentinized shell.

Serpentine ridges close in the southern end of Chiles Valley, and cut off the Knoxville shales, which are probably continuous northward to Pope Valley. This shale is unaltered, though greatly crushed, and contains the Lower Cretaceous fossil, aucella.

The two branches of Capel Creek come together just south of Chiles Valley, and turning eastward cut through the high ridge bounding Beryessa Valley on the west. This ridge is about 4 miles across, and the strata are well exposed in the cañon. The serpentine has a width of over a thousand feet at the base of the ridge where the creek enters the cañon. Thus the Cretaceous shales are cut off from the older series on both sides of the valley by serpentine.

The section shown in the cañon is very interesting. The ridge appears to be formed of rocks of the Metamorphic Series, with many intrusions of old eruptives. The strata are so little metamorphosed that they were at first taken for a part of the Cretaceous, but there is an absence of fossils and a considerable metamorphism in places, which, together with intrusives, which have been seen only in the Pre-Cretaceous Series, make it certain that they belong to the older series. In addition, the ridge is a continuation of the same one through which Pope Creek has cut its course, and where the metamorphism is certainly Pre-Cretaceous.

The rocks are so crushed in Capel Creek cañon that no regular strike and dip was observed. The shales are often crushed so as to form lenticular shells, while the sandstone is minutely jointed. Sandstone is the chief rock through the middle of the cañon. There are shales at the lower end. Occasionally there is shown a little slaty cleavage. At one spot several little branches of coal occur. Fossils ought certainly to show here if they were ever present. The float rocks from the side cañons show more silicification than those along the main one.

Beginning about the center and growing more abundant toward the east, are bodies of dike-like appearance, greatly decomposed. Very close observation is needed to distinguish them from the jointed sandstones, except when there is present an amygdaloidal structure, or traces of porphyritic crystals on weathered surfaces. Many of these argillaceous strata on the eastern side of the ridge, though greatly crushed, are apparently not more metamorphosed than the Knoxville beds. The last of the intrusives is a dark, hard, dike-like mass at the mouth of the cañon. Directly east of this there appears the well-banded shales and

sandstones of the Knoxville beds, dipping east at about 40° at a distance of 200 feet. Approaching the contact they become more and more steep till they are vertical. It is evident that an upward movement of the ridge took place, affecting the shales near it. The eruption of the amygdaloidal dikes took place before the Cretaceous, for the dikes, which were so numerous along the cañon, cease to appear when the Cretaceous is reached. At this point, where no serpentine has been intruded, the Cretaceous is not much crushed, but shows a very regular strike and dip a short distance from the contact.

The road from Beryessa Valley to Napa follows near the contact of the Cretaceous with the older rocks for several miles; the change always being abrupt from the soft shales to a hard-jointed sandstone, serpentine, or ancient intrusive.

The metamorphic range of hills which has just been described, in Capel Valley sinks beneath the Cretaceous, but rises here and there in tall pinnacles and cliffs. The ancient intrusives continue to be so decomposed that it is difficult to distinguish them from sandstone.

The older series occupies so subordinate a place in Capel Valley, and is so little altered, that very close observation is needed to find the contact, especially with the Knoxville shale on the west. The rocks often have no great depth, but appear to rest on the Metamorphic Series. No rock older than Cretaceous outcrops in any amount south of Capel Valley, the rocks being chiefly shales and heavy-bedded, tawny sandstones, resembling the Chico. A small outcrop of the metamorphic rocks was observed west of Wooden Valley, almost under the edge of the lava. South of Wooden Valley the volcanic material has covered up nearly everything along the ridge, almost to Benicia.

Sonoma, Mendocino, and Marin Counties were not investigated, but, according to the notes of Mr. Goodyear, they consist to a great extent of metamorphic rocks and intrusives similar to those described.

GEOLOGY OF SAN DIEGO COUNTY; ALSO OF PORTIONS OF ORANGE AND SAN BERNARDINO COUNTIES.

By HAROLD W. FAIRBANKS, F.G.S.A.

The topography of this region has been quite thoroughly described by W. A. Goodyear, in former reports of the State Mining Bureau. The structure of San Diego County is comparatively simple. Three main divisions might be made: the desert on the east, the Peninsula range of crystalline rocks in the middle, and the nearly level mesa on the west. The Peninsula range is supposed to represent the southern continuation of the Sierra Nevadas, but in just what relation it stands to the Sierras has been a matter of dispute. The Peninsula range in San Diego County forms one main mountain chain. It maintains this simplicity of structure southward, forming the backbone of the peninsula of Lower California. Northward it becomes broader and more complex, rising in the lofty San Jacinto and San Bernardino ranges on the east, and the Santa Ana range on the west, while the region between is filled with mountains and valleys irregularly disposed.

Complex as is the topography of this region, the geological problems, though often difficult to solve, are quite simple. The higher mountains are formed wholly of ancient crystalline schists and massive rocks, respecting the age of which a great diversity of opinion has existed; while the region bordering the coast consists of unaltered Cretaceous, Tertiary, and Quaternary deposits.

Owing to the very limited time given me to prepare my field notes for the press, they will be given substantially as they were taken in the field, without any attempt at systematic arrangement.

The crystalline rocks of San Diego County are varied in character, and of much interest. No opportunity has been given me to study the large collection made, and the determinations given are simply the result of superficial examination, and are subject to correction.

The bay of San Diego is bordered on the east by gently sloping mesas of modern Tertiary and Quaternary age. These unaltered strata are characteristic of the western slope of the Peninsula range through its whole extent. They sometimes rise as high as 3,000 feet; though in San Diego County they do not exceed 1,500 feet. The upper portion of these beds consists to a great extent of coarse, loosely cemented conglomerates. The rivers issue from the higher mountains through narrow valleys or cañons, and have cut valleys, often quite broad and with very steep sides, through the mesas to the ocean.

The Otay mesa has a height of about 500 feet, the western portion being somewhat higher than the eastern, indicating a recent elevation near the coast. The soil of the mesa is adobe, due to the decay of porphyry mountains to the east. Under the adobe there is a calcareous marl, often many feet thick.

The first exposure of the older rock seen as one goes up the Otay

River, is in a hill rising through the mesa about in the center of the grant. It is a part of the extensive porphyry intrusives, which, in southern San Diego County, form a number of high mountains between the granite and the mesa. To this formation belong the San Miguel and Otay peaks. This exposure on the Otay River is a felsitic breccia. It contains a felsite base (intimate mixture of quartz and feldspar), in which are imbedded fragments of felsite and chlorite. No more rocks appear for about 2 miles up the river. Then we reach the base of the long ridges which lead up to the Otay Peak. Some interesting rocks are exposed where the stream issues from the cañon. The greater portion are fine dark to greenish aphanitic rocks, with green chloritic or epidotic nodules. Bunches and dikes of coarse to fine grained porphyritic rocks occasionally appear. They probably belong to the diorite porphyrites. The rock continues very much the same for several miles farther east; at times it is almost wholly feldspar. In the cañon above El Nido Post Office it changes to a light green feldspar porphyry. Near the western edge of the Jamul grant a dark-colored porphyry takes its place, and a little farther east it becomes jet black, with small white feldspar crystals, producing a very pretty effect.

The mesa conglomerates extend along the top of the low hills bordering the valley nearly to the eastern edge of the Jamul grant. A great variety of rocks appear along the Campo road between the Jamul grant and Sheckler's, on the Cottonwood. Near the eastern end of the grant the porphyry is followed by fine-grained granitic rock, frequently becoming schistose. Numerous dikes and bunches of dark diorite cut through this rock. As Dulzura Post Office is approached, these rocks change to mica and hornblende schists, and are filled with intruded dikes of diorite porphyrites. Bodies of massive syenite and coarse granite were also seen. About Dulzura many of the dikes have the appearance of diabase. Between Dulzura and Sheckler's the country rock is largely micaceous and chloritic schists. Massive granite forms the high, rugged mountains east, extending in an arm westerly across the road. The schists have a northwest strike, vertical dip, and are evidently of metamorphic origin. They form a strip of country extending in the line of strike from near Sheckler's to the Sweetwater River, and are situated between the wide belt of porphyry on the west and the coarse intrusive granites on the east, which rise to form Lyon's Peak and other rugged mountains.

The first rock met east of Sheckler's, on the Campo road, is coarse hornblendic granite, so decomposed that a fresh specimen could not be obtained. Dikes of fine-grained granite intersect it in every direction. Three miles west of Potrero, mountains of olivinitic diabase rise on the north side of the road. This rock is very similar to many large bodies of intrusives through the mountains between Julian and the Tia Juana River. It has evidently been intruded into the granite, for dikes extend out, intersecting the latter rock.

Potrero is located in a valley of several hundred acres in extent, and surrounded by granite mountains. It has an elevation of 2,400 feet. South of Potrero, along the boundary line, the mountains show large areas of the dark dioritic and diabasic rocks. The hills immediately south of the valley consist of hornblendic gneiss; strike east and west. Eastward, toward Campo, the rock is chiefly a coarse white granite, very easily decomposed. It shows a slightly gneissoid structure for a number of miles. It does not seem to represent the bedding of a sedimentary

rock, but of parallelism of the constituents, induced in the magma by movement or pressure. Long, drawn out, lenticular inclusions are often present, and are arranged parallel to the schistose structure. These consist largely of hornblende, with little feldspar.

In the vicinity of Campo the topography of the country changes from that of high mountains and deep, narrow valleys, to an elevated mountain plateau with meadows and rounded granite ridges. The mountains are covered with brush, while live oaks are numerous in the valleys. The country maintains these features while gradually rising to the divide 8 miles east of Campo. The granite is so deeply decomposed along the summit region that no good samples could be obtained. Campo has an elevation of 2,600 feet. The bare, rounded ridges closely resemble those left by glacial action, but their slope is produced simply by the cleaving off successively of the more angular portions in great slabs. Many fine examples of this manner of decay appear about Campo. The corners are decomposed faster than the smooth surfaces, and thus finally a shelly concentric structure results. The fresh massive central portion weathers out like water-worn bowlders. The presence of rugged angular ridges results either from a less inherent tendency to decay, or to a comparative freedom from crushing. Four miles northeast of Campo is an outcrop of coarse hornblendic granite, with large six-sided mica scales and numerous yellow crystals of titanite. The height of the divide is 3,800 feet. Near the summit the rocky ridges all disappear and the country becomes covered with granitic sand. Erosion here is evidently very slight. The country descends gradually on the east to Jacumba Valley, being sandy for some distance. This finally gives place to bare, rocky ridges and cañons. Veins of fine granite, and others of feldspar and quartz, are abundant on the eastern slope.

Before reaching Jacumba Valley a body of mica and hornblende schist is encountered. The schists do not form a regularly defined belt, but often appear as inclusions in the granite. These inclusions have a very variable strike, and from their relation to the granite it is evident that the latter is intrusive.

Jacumba Valley empties northward into the desert through a narrow gorge. It has an elevation of 2,600 feet, the same as that of Campo. It is several square miles in extent, the greater part of which is in Lower California. The warm springs here are considered quite medicinal. The schists just described occupy a large area west and north of the cañon through which the valley empties. They are cut in every direction by dikes of granite and others, consisting of a very coarse aggregate of quartz and feldspar with a little muscovite mica. A high mountain several miles north of the valley is distinctly ribbed all over by them. The schists extend northward toward those which outcrop on the eastern slope of the Laguna Mountains and at Julian, but are cut off by a body of intrusive granite. They undoubtedly belong to the same series. Gold-bearing veins have been found in them a little north of Jacumba Valley.

At the north end of Jacumba Valley, and on the west side of the outlet, is an area of volcanic rock, probably basalt. It forms a tableland, gently sloping toward the valley, and rising 600 or 700 feet at its northern end. It is underlaid by gravels and conglomerates. Just east of this is a black butte, rising perfectly symmetrical to the same height. It consists of bedded lavas, with tufa at the bottom. In spite of the

fact that it is shaped like a crater, its structure is different, and it is probably a remnant of the flow which once covered the outlet to the valley.

The high range of mountains between Jacumba Valley and the desert has an altitude of something over 4,000 feet, but where the road crosses it, it is only 3,100 feet. Basalt outcrops also on the eastern side of the valley. North of the road to Mountain Springs it forms a series of plateaus, the highest of which reaches a height of 3,900 feet. It forms the summit of the range, being 800 feet above the granite forming the pass. South of the pass several miles the granite rises much higher and the lava lies along its western slope, extending an unknown distance below the line.

Large deposits of water-worn bowlders and gravels lie along the eastern slope of Jacumba Valley. Among them are pebbles of porphyries, black quartz, and others not seen in place in this part of the county. A short distance west of the summit they are found in beds with gravel and sandstone, dipping southwest. These late Tertiary deposits are overlaid by the volcanic beds. The volcanic plateau which rises so high north of the pass has a thickness of 500 to 600 feet. Massive and bedded lavas form the upper half of this thickness, the lower portion consisting of a volcanic breccia. The beds lie nearly horizontal. On the west are two lower terraces, also capped with lava and abutting against the higher. The whole is underlaid by sand rock of granitic origin. It is nearly level in places, in others it dips to the southwest. It is very strange that these lava beds, with nearly level flowage lines, should be found at such greatly varying elevations about Jacumba Valley, and be underlaid everywhere by such similar tuffs and sandstones. My investigations disclosed no volcanic vent, and it is possible that the lava issued from fissures, as was noticed elsewhere in the county. Another interesting question is the origin of the sandstones and conglomerates. The sandstone underneath the high plateau is higher than the divide at that spot, and the only granite within miles that exceeds it in height, is the narrow ridge which rises on the southeast. The erosion must have been very great along the ridges since the sandstones were deposited, but the valley cannot have changed much. There may have been great elevation along the crest of the range bordering the desert since the deposition of sandstone, tilting up the sandstone and lava on the eastern slope, but elevating without great disturbance those near the summit. Southeast of Mountain Springs is a body of bedded tufas reaching an elevation of 2,300 feet, and dipping to the east away from the range at a considerable angle.

The presence of these modern sandstones at so great an elevation nearly on the crest of the Peninsula range is a very interesting fact. Either Jacumba Valley was a lake, or a great elevation has taken place in comparatively recent times, raising the valley from the sea-level. Appearances indicate that during late Tertiary times this range was almost submerged beneath the sea.

The rocks between the summit and Mountain Springs are chiefly gneissoid, at times granitic. They contain bodies of fine dark mica schist, and many dikes of very coarse muscovite granite. The descent to the desert is very abrupt over bare granite ridges. Mountain Springs, an old stage station, is located on the side of the mountain at an elevation of 2,300 feet. From the springs the road descends along the dry bed of

an arroyo to the desert. The most of the distance is through a rocky cañon, where there is an excellent opportunity to study the relations of the gneiss and granite. For some distance down from the springs the rocks continue to be gneissoid, but through the lower end of the cañon they become more massive and coarse, and all the veins characteristic of the gneisses of the higher mountain region disappear. At the upper end of the cañon is a dike of very coarse granite, with large biotite crystals instead of muscovite. This is the only instance in which biotite was seen in one of these coarse dikes. Banded gneiss, varying from very thin to very thick bedded, alternate with other rocks, to all appearances massive granites, but in surface decay the latter break up into slabs of varying thickness, parallel to the schistose structure of the gneisses. The banding is caused by an excess of mica or hornblende, chiefly the latter, arranged in parallel layers. These strata are often very thin, varying from one fourth to one half inch and upwards in thickness. They are very regular, but often discontinuous; stop, and in course of a few feet begin again. These features are generally supposed to indicate metamorphic origin, but at one spot a body of dark mica schist is cut by a dike a foot wide or more of this dark banded gneissose rock. This dike cuts across the stratification of the mica schist, showing conclusively the intrusive nature of at least a part of these gneisses; and it is quite possible that the inclusions of mica schist are the only really sedimentary rocks present. In places the rocks which show this banding have the constituents arranged in the bands independent of any direction. At one spot a distinct, well-defined mass of mica schist, 15 feet across, is imbedded in a granitic rock. At one side this gneissoid structure extends through the inclosing rock and abuts sharply against the mica schist. The banding shows no constant direction; in the cañon it is northeast. The bands sometimes become wavy.

As the cañon opens out to the desert, hills appear on either side formed of volcanic tuffs. They dip northeast 30°. Underneath is a sandstone wholly unconsolidated and dipping in the same direction 40°. This contains no lava pebbles. The fragments of the tuff are quite varied in character and generally quite angular. They are imbedded in a volcanic mud, free from granitic detritus. In some of the strata appear thin beds of lava, seeming to represent a flow. These tufa hills extend northwesterly along the base of the granite mountains for 10 miles or more. It is not known how far they go in a southerly direction. In places they form mountains of considerable size high up on the side of the range. The range of mountains between this point and Carrizo Creek appears also to have some volcanic beds on its southern slope. The open desert at the foot of the mountains has an elevation of 1,200 feet. It slopes gently for miles in an easterly direction and consists largely of loose sand.

Between Mountain Springs and the summit is another illustration of the fact that lamination in a crystalline rock is no proof of its sedimentary origin. A small dike less than 2 inches thick cuts across a coarse biotite gneiss at an angle of 30°. It is separated from the gneiss by a thin layer of quartz and feldspar. It is made up of the same constituents as the gneiss, arranged so as to show a well-pronounced gneissoid structure. This is very similar to the large dikes seen in the cañon.

The road was followed back to Campo, and from there the Laguna

Mountains were climbed. The road ascends a long, narrow cañon on the southern slope. At the entrance to the cañon, 4 miles southeast of Buckman's Springs, the mountains are high and rocky, being formed of thin-bedded gneisses, which, in many places, blend into mica schists. They strike parallel to the mountain axis, a little west of north; dip 70° northeast. Three miles up the cañon the gneiss becomes thick-bedded and is finally replaced by mica diorite, which forms the hills on both sides. Granitic dikes outcrop near the junction and sometimes apparently in the diorite. There is often a blending between the two, as if the intrusion of both took place nearly at the same time. The region east of the southern end of the mountains is formed of coarse granite, decomposed to a considerable depth. The mica diorite extends northward, forming the whole central and western part of the mountains. On the east it is bordered by a slightly higher ridge, forming the crest of the mountains. This rock does not decompose as easily as the granite and gneisses on the west, and there consequently remains a mountain plateau having an elevation of about 5,500 feet. There is a considerable amount of pine timber and open meadows. The dark diorite forms one of the highest peaks of the Laguna Mountains, rising 6,250 feet. The highest portion of the mountains lies to the northeast, and is formed chiefly of a quartzose mica schist. From the eastern crest of the range a most magnificent view of the desert is obtained. The strata on the crest strike north 15° west, dip 70° northeast. The descent of 4,000 feet to Vallecitos is very abrupt. Near the crest it is almost as steep as the dip of the rocks. The mica schists in places approach gneiss in composition, but all of this series of rocks forming the crest and eastern slope very probably belong to the Metamorphic Series. South of this point the Laguna Mountains do not terminate so abruptly, but extend out in long, gradually descending ridges for many miles. The mica diorite extends north of the Laguna about a mile, when the schists on both east and west sides unite and extend north toward Banner. They are intruded by granite and diorite in many places. The body of diorite forming the Laguna plateau is about 8 miles long and 1½ to 2 miles wide. The highest peak is not over 200 feet lower than the Cuyamaca, rising 6,300 feet. The diorite seems to have been intruded in the middle of a considerable area of mica schists, for this rock outcrops on all sides. On the west, toward Pine Valley, they carry the gold veins of the Pine Valley district. The descent is very abrupt to Pine Valley and Buckman's Springs. The schists and gneisses extend about 3 miles south of the main portion of the mountains, when they are replaced by coarse hornblendic granite.

Buckman's Springs has an elevation of 3,400 feet. Here are some very excellent soda springs, the only ones I know of in this section of the State. A coarse, dark diabase outcrops in the edge of the mountains just north of Buckman's and also a little farther south, on the west side of the valley.

A narrow cañon leads up to the divide which separates the valley of the upper Cottonwood from Pine Valley. The western prolongation of the diorite of the Laguna Mountains appears near the road on the divide. The prevailing rock is, however, of a granitoid nature and filled with many large bunches of massive white quartz. Pine Valley has an elevation of 3,800 feet. Gneisses and hornblendic and micaceous schists outcrop between the valley and the divide east of Descanso. The strike

is north and south. One mile southeast of Descanso there is another outcrop of the coarse diabase or gabbro which forms so much of the Cuyamaca peaks. Descanso has an elevation of 3,400 feet. The rock which outcrops for a number of miles along the road to Stonewall is a coarse, easily decomposed granite, rising in rounded knobs over a rolling, brush-covered country.

The Pine Valley district lies in a belt of gneissose, mica schist, and quartzose rocks, which extend in a direction a little west of north. They begin about 2 miles south of Pine Creek and extend, probably unbroken, through to Banner and Julian. It is 4 miles north to the Deer Park district. The metamorphic schists widen as this district is approached. They extend from the desert slope to Deer Park, where a body of diorite has been intruded, and from there westward 2 miles to the Cuyamaca grant. A half mile west of the camp the slaty mica schists and quartzites are well defined. A vein of gold-bearing quartz has been traced for several miles in these rocks, and a number of locations have been made on it. The strike is north and south, dip 80° to the east. A body of white crystalline limestone lies in this formation, about 1½ miles southwest of Deer Park. The body of micaceous diorite which extends through this camp is about a mile long, and is quite gneissoid in places. Near its southern end it incloses narrow bands of hornblendic and feldspathic rock, containing garnets. The veins are numerous in this diorite, and extend in every conceivable direction. The diorite has been greatly crushed at some time, with fissures in every direction; hence, the irregularity of the quartz veins. The veins are generally bunchy, and not often very large. They seem simply to follow the exceedingly irregular fracturing of the diorite, which is decomposed to a considerable depth. The work thus far in this district has been confined to the surface, so that nothing can be said in regard to the permanency of the veins. The elevation of the camp is 4,600 feet.

Two miles northward an outcrop of coarse biotite muscovite granite was met. It is about 2 miles long and 1 mile wide, having schists on all sides of it. This is the only example of typical granite (according to Rosenbusch) that was seen in Southern California. A broad valley, occupied by Mr. Harper's ranch, has been eroded in the center of this granitic mass.

Northward, along the crest of the range overlooking the desert, mica slates appear. They are so little metamorphosed as to closely resemble argillaceous slate. They strike a little west of north, dip 70° to 80° east, and maintain the same character north to Banner and Julian.

The road from Julian to Stonewall crosses mica schist and gneisses for about half the distance. Then we met outcrops of a dark basic rock, ranging from fine to very coarse texture. It extends southward and covers a large extent of country. The three Cuyamaca peaks, the highest in the southern part of the county, are formed of this rock. This rock was again met about half a mile west of the Stonewall Mine. It extends westward across the mountains for at least 2 miles, and some miles south of the main peak. In places it has a schistose structure. Near the outlet of the Cuyamaca reservoirs it is filled with vein-like aggregates of coarse hornblende crystals, which are probably the result of secondary crystallization in fissures or cracks of the almost consolidated magma.

The formation in the vicinity of the Stonewall Mine is biotite gneiss. Toward the east it is not sharply defined from the mica schists. On the

west it is generally more granitoid, though at one spot near the lake there are finely laminated schists, dipping 70° southwest. Southward, also, the gneisses become more massive and coarse. At the northeastern base of the main peak a body of coarse granite is partly inclosed in the norite. This norite assumes a dioritic habitus near the granite, with the development of biotite mica.

The valley of the Cottonwood was followed down several miles, when it was left and the Morena Valley traversed to its head. The mountains south of the valley are formed of a dark syenite. North and northwest the higher mountains consist of granite, with a great development of mica and hornblende schists along the slope facing the valley. Many granite dikes have been intruded into the schists. North of Mr. Candler's there is a great dike of pegmatite, carrying small garnets, tourmaline, mica, and large masses of quartz. This pegmatite dike cuts across the cañon, forming a precipice on its lower side. On the upper side the soil has been retained, forming a small but fertile valley. The strike of the mica schists on the north is quite unusual, being north 75° west, dip nearly vertical. Dark syenite lies on the west of this little valley. Morena Valley has an elevation of 3,400 feet. A rough road leads over the mountains west to McClain's ranch, a distance of 10 miles; the highest point reached having an elevation of 4,000 feet. Near the summit there outcrops a body of coarse eruptive rock, probably a diorite. It consists of coarse hornblendic aggregates in a light-colored feldspathic matrix. This is followed by syenite, and that by coarse white granite as far as McClain's. The granite about the valley is coarse, with dark, fine crystalline inclusions. It has every character of a truly eruptive rock, even to the minute spaces between the components, left at the time of crystallization. The road now descends to a branch of the Cottonwood, and from the creek there is a long, gradual ascent to the pass north of Lyon's Peak. The north side of the pass is formed of another high and rugged granite range. This section is one of the wildest to be found in San Diego County. The mountains are bare granite, often precipitous; the valleys small and covered with brush. Crystalline limestone is reported to have been found in the granite 5 or 6 miles northeast of Renney's Pass. A very interesting eruptive rock outcrops east of the pass, on the north side of the road. In places it resembles the norite from Cuyamaca peaks. The rock consists largely of large, dark, cleavable crystals filled with small granular crystals of a green color, probably olivine. A large portion of the dark crystals are undoubtedly pyroxene, though there are some showing hornblende cleavage. This is one of the most peculiar and interesting rocks seen in the county, but, from lack of any opportunity to make a microscopic examination, no more definite definition can be given.

Coarse granite extends some distance west of the pass. It is decomposed to such a depth that no specimens could be obtained. A mile west of the pass a fine granite, apparently metamorphic, replaces the other. It contains much quartz, little mica, and yellowish feldspar. Some distance down the new grade a large body of diorite outcrops. It is one of the southern arms of a great mass of coarse, dark rock which forms the high mountains about Dehesa Post Office, on the Sweetwater. A large portion of this rock very closely resembles that forming the Cuyamaca, and is probably a gabbro.

Near the foot of the grade, 2 miles east of Jamul Post Office, this rock

is very coarse, with large hornblende crystals. It extends out in the form of arms or dikes into the adjoining granitic rocks. This rock is very tough and heavy. Gneiss outcrops for 2 miles westward. It varies between thin-bedded micaceous strata and thick-bedded, almost granitic forms. It strikes north 15° east, dips 70° to 80° east. Farther down, toward the Oakdale House, this is replaced by coarse eruptive granites. Just below the Oakdale House there is a very interesting contact between granite, quartz porphyry, and diabase. The first rock exposed below the house is a rather dark micaceous syenite. Beyond this the rock becomes coarser, containing large grains of quartz and glassy feldspar, with inclusions of a very dark diabasic rock. In a little cañon which comes down to the road from the east, this rock comes into contact with one which varies from a feldspathic mica schist, through a gneiss, to a quartz porphyry. The junction is very irregular and the two rocks are slightly mixed; sometimes branches of the syenite are partly inclosed in the porphyry. Some portions of the syenite show gas pores, or spaces left at the time of consolidation, one fourth to one half an inch in diameter. They are partly filled with secondary quartz. The next rock exposed up the cañon is a mica schist; strike 15° west, dip vertical. Quartz porphyry follows this, then an irregular dike of granite, in which are imbedded nodules of quartz porphyry, some nearly a foot in diameter. Above the granite there appears a granitoid gneiss, with many cavities, arranged with their longer axes parallel to the schistose structure. This changes into a coarse, knotty granite, containing large

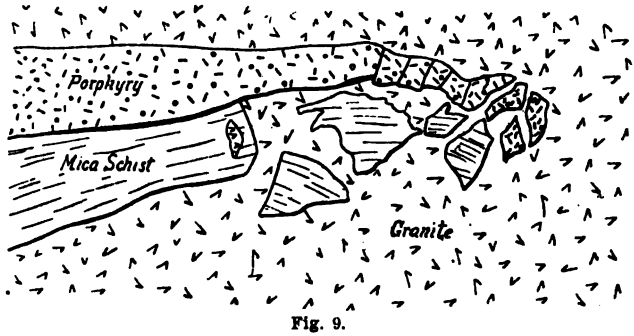


Fig. 9.

nodules of dark petrosilex. A slight blending is noticeable. Farther up this is succeeded by a micaceous quartz feldspar porphyry, showing a somewhat gneissoid structure. It is cut at right angles to this structure by jointing planes lying thickly together. It has a milky, vitreous luster, and contains inclusions of very coarse granite. The next rock exposed is a diabase 200 feet across. It is coarse in the middle and aphanitic on the edges. Adjoining it are bunches of granite and a fine, dark, compact mica schist, showing traces of little pebbles in places. The schist changes to a petrosilex, which comes in contact with a dike of very coarse granite. At the upper edge of this granite outcrop, and inclosed in it, is a stratum of fine, dark mica schist and a dike of quartz porphyry. At one end these inclusions are hidden, but at the other they have been bent, fractured, and the pieces separated some distance in the granite. (Fig. 9). This is a most interesting example of the intrusive nature of the granite.

Fig. 10.

The granite dike is bounded on its upper side by one of aphanitic diabase 2 feet wide, followed by granite again. Nodules of the diabase appear in the edge of the granite. A stratum of wavy quartzose gneiss 10 feet wide follows the last dike of granite. It changes across the strike into a coarser gneiss, and that into irregular and partially blended masses of coarse granite, filled with long fragments of porphyry similar to a dike on the east. (Fig. 10.) The quartz porphyry is very compact and brittle, and has a conchoidal fracture. The porphyry dike has a width of 8 feet. About it is still another dike of granite 12 feet across, and containing many long fragments of a diabasic rock, which appears next in the succession.

The diabase is cut by small, interlacing granite seams for 6 or 8 feet, and also contains some large, irregular, lenticular masses of the same rock. Still farther is another dark dike cut squarely across by granite. Fine granite and quartz porphyry dikes occur still farther east. The porphyry dikes all run about north 35° west, average dip 70° southwest. They extend along the summit of a ridge for more than half a mile, when the coarse granite becomes the country rock. On the summit of the hill at the head of the cañon are strata of metamorphic rock, and also some veins of pegmatite, cutting across the porphyry. This wonderfully varied succession of rocks does not cover a width of more than a quarter of a mile. The relations exhibited here prove that the porphyry and diabase, as well as the schists, are older than the granite. The strip of country between the ancient porphyries of San Miguel and the coarse granite of Lyon's Peak and the ranges north is remarkably rich in its variety of intrusive rocks.

On the north bank of the Sweetwater, just above where the Spring Valley road crosses, is a large exposure of coarse granite, containing so many inclosures of a dark dioritic rock as to present the appearance of a conglomerate. It is cut by bunches and ramifying dikes of fine granite and diorite.

At Dehesa the granite is replaced by norite, which forms a high mountain on the north side of the river, and extends southeasterly 3 or 4 miles, forming two high peaks. In this are veins of hornblende aggregates, and in general appearance the rock bears the closest resemblance to that on the Cuyamaca.

The crystalline rocks exposed between the Sweetwater and El Cajon Valley generally show more of a dioritic composition than granitic.

They have a glassy feldspar, much hornblende, and little quartz. There are two varieties: one is light colored, and forms most of the country; the other is darker, occurring in bunches and dikes. Southwest of the valley the rocks are more granitic. On the road to Spring Valley they give place to a hard, light-colored felsitic rock, containing specks of chloritic matter. Masses of granite appear in places, intruded into the rock. As it decays it becomes jointed, and seems to be reduced mostly to kaolin. Near the railroad, northwest of Spring Valley, rocks outcrop which belong to the series of dark intrusives, tuffs, and porphyries so extensively developed west of the granite. The rock here has a fragmental appearance in weathered specimens. It has a dark green color, and is of uncertain composition. The most western exposure of this rock, before it becomes covered by the mesa, has much the same character. It is without doubt an ancient intrusive, very greatly altered. It contains bunchy dikes of white feldspathic composition, which easily reduce to kaolin. The whole exposed width of these rocks west of the granite at this point is over a mile, about half of which is tufaceous. By tufaceous is not necessarily meant a fragmental intrusive deposited in water, but for lack of any other term it is used to designate those fragmental intrusives of plutonic origin which are so abundant in California.

Between the Oakdale House and the Sweetwater River, on the road to the dam, dark quartz mica diorites outcrop. They have been intruded by coarse granite in veins and bunches. A body of dark aphanitic rock, of uncertain origin, is inclosed in the diorite near the river. It may be a portion of the aphanitic rocks associated with the porphyries farther west. A little distance down the river the diorite is succeeded by conglomerate rocks, containing small garnets. The fragments are feldspathic in composition. Dark feldspathic porphyry then forms the prevailing rock for some distance. It shows great variations. Much of it contains no distinct crystals of feldspar, but is mottled by light green felsitic bodies of irregular outline. These contain chloritic substances, which decay out, leaving holes. There is a great variety of these ancient intrusives exposed along the sides of the river north of San Miguel Peak. None of the other crystalline rocks in San Diego County appear so old or show so much alteration.

Farther down the cañon the rock assumes a fragmental appearance, having masses of feldspar in a dark matrix. It finally becomes a pronounced breccia, being formed largely of angular, felsitic fragments. The base in which these fragments lie decays away and leaves them standing out on the surface. This may be a tuff formed in water, but the matrix has undergone such alterations that nothing certain can be said about it. This breccia continues to the lower end of the cañon. An interesting, light-colored dike was observed here. It is so filled with minute spherical amygdules as to resemble in structure an oolitic limestone. The breccia continues as far as the Sweetwater Dam, where it is replaced by feldspar porphyry. The porphyry shows much variation; in places no feldspar crystals are present, chlorite taking their place. These rocks disappear a quarter of a mile west of the dam, and mesa-like hills extend down to Chula Vista. These consist of soft sandstones and some calcareous deposits. Dark rocks, belonging to the series just described, outcrop near the mesa road from San Diego to El Cajon. It forms a long ridge south of La Mesa. The rocks are in part tufaceous, and in part dark green and massive, with felsitic inclusions. Near the

Eleven-Mile House the granite is filled with dark, bowlder-like inclusions. Hornblende is an important constituent of the granite. It is more than likely that many of these so-called granites are really diorites. The mesa formation terminates in an abrupt escarpment on the west of Cajon Valley. The valley comprises many thousand acres of very fertile land. Granitic knobs rise in many parts of the valley, showing that the alluvium deposit is underlaid by it at no great depth. North of the valley, for a number of miles, the crystalline rocks are covered by the mesa conglomerates. Granitic rocks are the only ones exposed for many miles east of Lakeside. Just above Forster's there is a small outcrop of gneiss and mica schist; strike north 35° west, dip 70° northeast. The rock exposed along the grade is a coarse biotite granite, with much quartz and glassy feldspar. A dike of quartz porphyry varying to granite porphyry outcrops by the road at the top of the grade. This does not seem to be sharply defined from the adjoining granite. A dark hornblende granite or diorite begins here and outcrops along the road for several miles toward Ramona. Three miles from the town there appears a dark rock with a somewhat resinous luster. It is probably a diabase. The Santa Maria is a large, plateau-like valley, with low granite hills surrounding it. Light-colored granite, becoming somewhat hornblendic, extends some distance east of Ramona, when it is replaced by a dark diorite. The latter extends along the road for 2 miles. It has glassy feldspar, and in places much mica. Four miles west of Ballena the granite is filled with pegmatitic veins, running in a northwesterly direction. They carry brittle crystals of black tourmaline, garnet, and muscovite mica. East of Ballena the rock becomes coarser and somewhat gneissose, with an abundance of mica. There are no bedding planes, simply a parallelism of constituents. This schistose structure has a northwest direction. The gneiss changes to mica schist on the grade above Santa Ysabel. The schist alternates with occasional strata of quartzite; strike north 25° west. The quartzite is a white, fine, granular variety, containing a little mica. Coarse gneiss outcrops again farther up the grade; at the top it becomes finer, carrying some hornblende, and alternating with strata of fine mica schist; dip northeast. The gneiss often becomes granitoid. The lamination has no constant direction, and resembles a flowage structure. This granitoid gneiss extends to within a mile of Julian, when there is quite a sharp transition to a gneissoid mica schist. That gives place to a fine schist, and a quarter of a mile west of Julian to a pearly hydro-mica schist. The schists strike north 20° to 30° west, dip 70° northeast. At Julian the rock is a dark, thin-bedded mica schist, usually termed a slate. There are also dark felsitic rocks and some gneisses. The belt of dark slaty mica schists is about half a mile wide. Toward the Balkan Mountain the rocks become more gneissoid. This mountain seems to be formed wholly of gneiss and mica schist. In some places the rock is nearly massive, and contains a large amount of quartz.

The rocks forming the mountains near the road from San Felipe to Vallecito are nearly all gneissoid. The real desert begins on leaving San Felipe Valley. The road extends southeast for 5 miles and then turns southwest, descending a narrow, rocky gorge to the head of Vallecito Creek. Near where the road turns to the southwest, the gneisses are cut by innumerable dikes of coarse granitic composition. Many of these run parallel, cutting across the strike of the gneisses, and give the

appearance of a bedded formation. In the cañon, before reaching Vallecito Creek, mica schist appears. It is bent and twisted into every conceivable direction, and varies exceedingly in structure and composition in the course of a few feet. The dip is northeast, and often at a small angle. The granite dikes often carry garnets, being quite similar to those between Julian and Banner. They were probably intruded after the eruption of the granite, and the related metamorphism.

At Mason's granite and gneiss both appear as intrusives in the schists, and are themselves cut by coarse dikes similar to those described. Between this point and Banner, in a direct line, gneiss is the prevailing rock. The high mountain east of Banner is more granitoid.

There is a sandy valley of considerable extent about Mason's; eastward a low ridge is crossed, and the road descends to Vallecito Valley between barren granite mountains, gradually descending until the open desert is reached. When the granite is hard these mountains are very rugged, but in places they are covered so deeply with soft, decomposed material as to closely resemble the Tertiary deposits farther east. The mountains often show pale purple to brown tints. On examination they appear to consist of a white granite, which has been so shattered as to break up into pieces, averaging not over 2 inches in diameter. This rock presents a very similar appearance for miles, particularly on the north side of the creek.

At Palm Springs the soft clay beds of late Tertiary age begin to appear. They dip in all directions, though that to the south and southwest is the most common. Toward Carrizo Station these are often covered by granitic detritus. The Tertiary beds widen out where the road strikes Carrizo Creek, and at Carrizo Station they have a width of nearly 10 miles. They rest against a granite range north of the creek and south along a long ridge which terminates in Carrizo Mountain. They also extend a long distance up Carrizo Creek. Four miles below the station harder sandstones and strata of shells cap the clay hills. This shell layer near the creek is 10 feet thick and contains pectens and oyster shells, belonging to the Miocene-Tertiary. The clay hills which surround Carrizo Station form a veritable Bad-Land. They show many different colors, and are perfectly devoid of any vegetation. They have been eroded into a most confused network of hills and cañons, and are so soft that it is difficult to travel over them. Six miles below this station and a mile north of the creek there rises a rugged granite range, facing the open desert. It rises from the desert quite precipitously nearly 2,000 feet, but blends westward into the ridges which run east from San Felipe. The granite is coarse and deeply decomposed. Sharp, angular grains of quartz stand out so prominently as to tear anything with which they come in contact. The thin-bedded shell strata rest against the slopes of the mountain, and near the southern end rise against the eastern slope at a very high angle in sharp, jagged points. These strata rise above the granite ridges at the point where they occur, and dip fully 70° to the east. (Fig. 11.) Resting on the summit of this granite ridge, and immediately west of the steeply inclined and jagged points of the Tertiary strata, is the southern outcrop of a bed of coarse, hard sandstone, which rises along the summit of the ridges to the north and dips west, extending down the western side of the range for a thousand feet or more, dipping at an angle of about 30°. This sandstone outcrops along the crest of the ridge for nearly a mile. It is, however, not absolutely

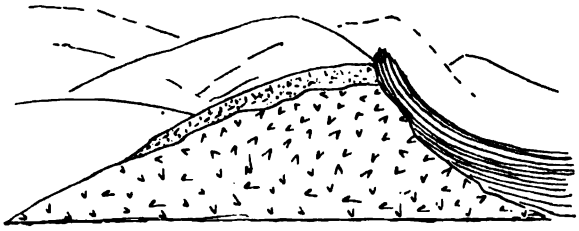


Fig. 11.

continuous, the granite rising through it in places. Near the southern end it is so highly metamorphosed as to be with difficulty distinguished from the granite at the contact. In fact, the two formations have become so intimately united, that a fracture of the granite made near the sandstone, instead of stopping at the contact, extends into the sandstone, so that the two rocks break off together. The contact is so exceedingly irregular that it seemed at first sight as if the sandstone had been intruded by the granite. Deep, narrow crevices extend into the granite, and are filled with sandstone. Some granite bunches are almost inclosed in the sandstone. The most interesting feature of this sandstone is the presence in it of an abundance of well-preserved corals of a type fully as old as the Cretaceous. Fragments of two species of a large oyster and poorly preserved specimens of univalve and bivalve shells are also abundant. There are at least two species of coral, many specimens being at least a foot in diameter. The sandstone is literally filled with them toward the southern portion of the outcrop. They also extend down into the crevices and cavities in the granite. The sandstone shows somewhat less metamorphism toward the north, where it contains some strata of pebbly conglomerate. The granite is intersected by many veins of coarsely crystallized feldspar and quartz. From these veins many of the pebbles in the conglomerate have been derived. At the highest point of the ridge the sandstone has the greatest thickness. Here it is broken up into great blocks 15 feet square, piled in the greatest confusion, as if by an earthquake. One great mass overhangs the almost precipitous granite escarpment at an elevation of 1,000 feet above the desert. Many fractures extend from the sandstones through into the granite. The sandstones, as well as the granite mountains north, have been baked a dull red color by the intense heat of the sun. To account for the peculiar position of this sandstone, as well as the steep inclination of the Tertiary beds at the southern end of the mountain, we must suppose that an extensive fault has taken place along the edge of the range facing the desert. The general inclination of the Tertiary beds to the west and southwest is also evidence of an uplift along this line.

Carrizo Mountain was ascended from the north by following up a wash through the clay hills. At the foot of the mountain there is a small outcrop of ancient volcanic rock greatly altered. This rock rests against the limestone which forms a large part of the north end of the mountain. The limestone is crystalline in every portion. The strike, as well as that of the schists and quartzites by which it is inclosed, is north 30° to 40° west, dip 75° to the southwest. The color of the limestone varies from white to streaked and variegated. It was carefully examined for fossils, but no traces of them could be found. The limestone is, however,

filled in many places with the holes of borers, and one small incrusting coral and one barnacle were found. The elevation of the north peak is 1,700 feet, and these were found nearly at the top. Everything points to a great elevation here in times so recent that the atmospheric agencies have not yet had time to remove the surface exposed to the ocean waters. Another factor enters into this time computation, however, and that is that in this climate, where the rainfall is so slight, a great many years are required to effect slight changes. Toward the south peak the rock is almost wholly micaceous and quartzose schists. Judging from the great amount of metamorphism shown by these rocks, fossils, if they ever existed, must have been destroyed. At various points on the northern end of the mountain are horizontal deposits of a soft, shaly sandstone full of fossils, similar to those found north of Carrizo Creek. The corals are very large and perfect. Some nearly entire specimens of large oysters were also obtained, but most of the bivalve shells are represented only by casts. With all the exploration which has been done, it seems probable that these beds have never before been seen.

Professor Blake, geologist of the Pacific Railroad Survey, passed up Carrizo Creek in 1853, but, from the statements made, it seems his observations were confined to the immediate vicinity of the road. His is the only geological party that has visited this region up to the present time. The vicinity of Carrizo Mountain is a favorite one for prospectors, and every winter it is visited by a number of parties. As yet no important discoveries have been made, and I cannot say that I think the region is a favorable one. Silver has been reported from the southern slope of Carrizo Mountain, and at one time there was considerable excitement. The mountain, though formed wholly of metamorphic rocks, does not appear to have been mineralized to any extent. Only one dike was seen on the mountain, and that was of a coarse, granitic nature.

There is not the slightest doubt as to the presence of a non-conformity between the Miocene-Tertiary and the coral-bearing sandstones. Specimens of the coral were sent to the National Museum, and were pronounced similar to some from the lowest Cretaceous of Texas. As to the age of the limestone and associated metamorphic rocks, they are unquestionably Carboniferous or older. A float piece of silicious limestone was found containing some shells, but no opportunity for their investigation has yet occurred. The Tertiary beds are covered, wherever any of their original surfaces yet remain, by a great variety of washed bowlders.

With regard to the structure of this eastern slope of the Peninsula range, I can hardly agree with the views before expressed, that there are to be seen here evidences of an enormous fault, to which the steep escarpment toward the east is due. The eastern side of the range, so precipitous in places, has been compared to that of the Sierras in structure and general features. It is true that this descent is very abrupt in places, but in others it is almost as gradual as the western slope. For instance, the gradually descending ridges which extend east from Banner for nearly 30 miles, show no indication of any fault, save at the mouth of Carrizo Creek, where there has undoubtedly been a fault of considerable importance. The very abrupt descent east of the Balkan and Laguna Mountains is due solely to enormous erosion, for both north and south ridges extend past them for many miles into the desert.

The San Jacinto Mountains also send out long arms into the desert, and below the boundary Signal Mountain and a connecting range seem

to be merely a spur of the main system. The rocks of the metamorphic belt at Julian and Banner, and farther south, dip to the northeast, indicating a great fold rather than fault, with the most strongly pronounced intrusive granites and diorites at some distance on each side.

It is not generally known that an ancient auriferous gravel channel exists in the county. It begins about a mile north of the old stage station, and 3 miles west of Ballena Post Office, where there rises a hill shaped like a whale's back (hence the name Ballena), covered with washed gravel and bowlders. The main portion of the channel which has escaped erosion begins south of the stage station, capping a hill which has an elevation above the sea of 2,400 feet, being a little lower than the so-called Whale Mountain. The gravel is 50 to 100 feet thick, and has a width of 2,000 feet or more. It rises 300 to 500 feet above the valleys and cañons on its sides. It extends in a direction a little south of west for about 4 miles, terminating on the south of Santa Maria Valley. A granite ridge runs 2 or 3 miles farther in the same direction, probably preserved by the gravels, which are now gone. A pretty valley, a mile long, has been eroded in the eastern end of the gravels, down to the underlying granite. Placer mining has been carried on for years here in a small way by Mexicans. Gold is said to be scattered everywhere through the gravels, which are often very firmly cemented. Lack of water, for the ridge is higher than any of the surrounding country, has prevented work on a large scale. Lately a mining district has been organized, and it is proposed to bring water 7 miles in pipe. In the gravels are washed bowlders, many of them being 2 feet in diameter and well polished. The remarkable thing about them, however, is that they are nearly all porphyries. The most abundant is a red feldspar quartz porphyry. Quartzite bowlders of all colors are numerous, and there are a few of the basic diorite so common in portions of the county. Garnets are said to be very abundant in the gravels, and many bowlders of a schist carrying them are also present. The matrix of this rock could not be made out in the field; it is very tough and heavy, and has never been seen in place. The red porphyry bowlders resemble those on the mesa farther west, but have never been found in place. Never, in the mountains east or north, has porphyry of this kind been seen, either by myself or described by others. From the old stage station the upper course of the stream was north and south as far as it can be traced. There are indications that one branch extended easterly toward Julian. These gravels appear on a hill surrounded by deep cañons, about 2 miles east of the top of the grade above Foster's. At the top of the grade the hills on the west are flat-topped, and covered with gravels to a depth of 150 feet. These have much the same character, and probably belong to the same channel. More investigation is needed to determine whether the course of the old stream was down toward the San Diego River, in Cajon Valley, or west toward the high mesas south and southeast of Poway Valley. It seems probable, however, that the stream flowed west, and that the mesas have been formed partly from the bowlders which they brought down. This mesa, as well as the gravels at the head of the grade, has an elevation of 1,500 feet. The source of the porphyry bowlders and the garnetiferous schists of this old river is a matter of great perplexity. The gravel deposit has every characteristic of an old river channel, and not that of an elevated arm of the sea; besides, the presence of gold in the gravels indicates their derivation from the country farther

east. The gold may have been derived from Julian or Mesa Grande, or some more remote point. The river must have flowed across the gold belt, but then the question arises, how could a river of such magnitude have existed so near the summit? The only way out of the difficulty is to suppose that a great uplift has taken place along the crest and western slope, coupled with an enormous amount of erosion; and that this stream once, before this great change took place in the configuration of the country, headed many miles to the northeast, far beyond the drainage of the western slope. The bowlders consist largely of hard rocks, and are very smoothly rounded and polished, indicating that they have been transported a long distance, and subjected to attrition through a protracted interval. It is quite possible that this river emptied into or near San Diego Bay, and that the immense beds of bowlder conglomerates about the bay owe their formation largely to this river action.

The first outcrop of crystalline rocks in Mission Valley is about 3 miles above the old Mission, where the San Diego River enters a cañon. It is a volcanic tufa, consisting of grayish to greenish fragments of a fine-grained rock imbedded in a brown matrix. This has a width of about half a mile. Along the cañon, dikes of a greenish amygdaloid have been intruded in the rock, and are particularly numerous north of the river. One of these dikes in the cañon was observed to be amygdaloidal in the center. Farther up the cañon there is a great variety of tufas. The first contains feldspathic and hornblendic fragments nearly blended in a base consisting of crystallized feldspar and dark chloritic particles. Above this is a dike of brownish crystalline rock, much altered; the only distinguishable mineral being feldspar, in small crystals. Then follows another tufa, with nearly blended micaceous fragments. The next rock is a fine crystalline one with very regular bedding planes, a foot or more thick; dip 30° to 40° southeast, strike north 35° east. Then follows a dark, aphanitic, structureless rock for some distance. At one point a branching dike of almost pure feldspathic material spreads out into this aphanitic rock in radiating arms. Apparent bedding planes run through them, as well as the country rock, showing that these planes are not those of sedimentation, but are due to some secondary cause. These rocks occupy the cañon for 1½ miles, and are all undoubtedly of volcanic or intrusive origin. A series of rocks of metamorphic origin outcrops a thousand feet along the cañon. The first of these is a micaceous felsite. That is followed by fine-grained granitic rocks carrying garnets, and this by a hornblendic felsite. The latter finally becomes mixed and blended with a coarse micaceous diorite, containing a glassy feldspar. This rock is the chief one exposed through the cañon. It has granitic and syenitic facies. The tuffs exposed at the mouth of the cañon extend in a direction a little east of south for 3 miles, until covered by the mesas which extend west from Cajon Valley. They show a comparatively uniform character, the fragments being generally nearly blended. The ridge which these rocks form is separated from the granite by an elevated mesa a mile wide. The tuffs are exposed along Chaparral Cañon to within 2 miles of the mission.

The granite ridge at the lower end of Cajon Valley does not extend more than 2 miles north of the cañon, when it becomes covered with bedded deposits and bowlders of late Tertiary age. Granite does not appear in Sycamore Cañon until the northeast boundary of the Cajon grant is reached. High hills of gravel and bowlders lie east of the

cañon and extend toward Foster's. The main body of granite is met at the head of the cañon. It extends along the east side of the road to Poway Valley. Bunches of dark, coarse diorite occur in it in many places. The gravel mesa south of Poway Valley has an elevation of 1,200 feet. Small areas of gravel also remain on the hills northeast of the valley. The granite ridge, flanked by porphyries, does not outcrop very prominently south of Los Peñasquitos Cañon. The ridge southwest of Poway Valley seems to be formed largely of gravels, rising 1,500 feet.

The usual brecciated tuffs outcrop in the gulches and along the creek just above Los Peñasquitos ranch house. They appear along the old road to Escondido for 2 miles. A body of chloritic granite appears in the center in the form of a long dike, extending from the Peñasquitos Creek a mile or more north of the road. Toward the east the breccia becomes finer and almost loses its fragmental character. Between this formation and the granite a dark micaceous felsite, probably metamorphic, outcrops. The fragments in the tuff are diabasic at times and at others largely petrosilicious and feldspathic. The crystalline rock on the east is, perhaps, more nearly diorite than granite, as the feldspar is chiefly a glassy one. Black Mountain is formed of this dark breccia, while the high range of mountains which rises on the north and extends northwesterly between San Bernardino and the ocean, is formed partly of granitic rocks and partly of the tuffs and porphyries, the latter lying on the west.

A rolling, hilly country, containing much good land, stretches north toward Escondido. Remnants of the mesa conglomerates remain in places on the eastern edge of the Peñasquitos grant. The granite is coarse and rises in huge, rounded knobs along the road. A little south of San Bernardino Post Office there rises a conical peak of micaceous diorite. A somewhat similar rock, but more diabasic in appearance, forms the mountain immediately west of the Post Office. This formation extends northwesterly for several miles, having a width of about a mile. The rock over much of this area closely resembles the gabbros and olivinitic diabases from the southern part of the county. It is penetrated by dioritic and granitic veins, in which the structure is often pegmatitic.

At the point where the road stops at the entrance of the cañon of Diablo Creek, this basic formation is replaced on the west by a massive, jointed quartz rock, containing a little feldspar and chlorite, and in places becoming granitoid. It often has a fragmental character, with the quartzose bodies imbedded in a matrix more granitic, or simply darker and chloritic. This rock is quite uniform for 3 miles down the cañon, quartz being the predominating constituent. It is very probable that this represents an original sedimentary terrain. It is followed on the western slope of the range by the dark tuffs before described. Here the matrix is often porphyritic, with a fluidal structure. Portions are real porphyries. A mile east of Olivenheim it resembles diorite porphyrite. The last exposure seen on the west was of the usual tufaceous character. This formation narrows northward, and on the road to San Marcos shows the width of a mile.

Northwest of San Marcos there is a large body of metamorphic rock, chiefly felsite schists and feldspathic quartzites. These extend in a northwest direction toward Buena Vista, but there are not many exposures. Dark diorite outcrops south of Buena Vista, and extends west for a mile and a half, when it sinks under the Tertiary deposits. The last outcrop

seen was a dark micaceous diorite. A mile west of this point there is quite an outcrop of diabase containing an excess of dark feldspar. The sandy clays extend west from this point to Oceanside. Near Buena Vista station the diorite is impregnated with green copper carbonates, and a considerable amount of work has been done, but evidently no paying bodies of ore were found. Syenite outcrops near Kelly's ranch house, and in the hills east. The crystalline rocks come nearer the ocean here than at any other place in the county.

Between Escondido and Moosa Cañon, granites, with bunches of dark diorite, are the only rocks seen. A broad, sandy valley extends up San Luis Rey River to within 5 miles of Pala, when the high granite mountains close in, forming a cañon. The valley widens at Pala, and for many miles a broad, sloping deposit of bowlders and gravel borders the river, and rises high against the foot of Smith's Mountain. It is often 2 miles wide and represents a great amount of erosion. A mile northeast of Pala is a high hill of diabase, similar to that in the southern part of the county. On the eastern slope of this hill is an enormous pegmatite vein, carrying a very interesting set of minerals. This vein is twenty or more feet wide, and dips west at a small angle. There are masses of great size of almost pure mica and feldspar, or quartz and feldspar—in the latter case very fine specimens of graphic granite have been formed. Near the southern end of this vein is a deposit of lepidolite mica, 10 feet thick at the widest part, and appearing in detached bodies for several hundred feet. It is fine-grained and shows a pale purple color. In places it is pure, in others filled with large radial aggregates of pink tourmaline (rubellite). Some of the aggregates are a foot across, others are long and slender, with arborescent forms. North of the main deposit it is found in quartz in fan-shaped aggregates, the crystals being more than a foot long, but greatly decomposed. Black tourmaline is abundant in the pegmatite surrounding the lepidolite, but in poor, brittle crystals. Green tourmaline is present in places in the form of minute grains. Garnets are also to be found in places. The vein as a whole is inclosed in the diabase.

The western end of Smith's Mountain shows many bodies of dark dioritic rocks. The major part of the rock is, however, gneiss and mica schist, all very easily decomposed, leaving an immense amount of bowlders and gravel along all of the gulches. Mica schists cover an extensive area along the southern slope of Smith's Mountain, on the Pauma grant. These are undoubtedly a continuation of the schists of the Julian belt, but carry no minerals. The belt of schists extends nearly if not quite through to Julian. Warner Valley is located at the head of San Luis Rey River. It is entirely surrounded by granite mountains. There is not as great a variety of intrusive rock here as in other parts of the county.

Point Loma forms a peninsula, the greatest length of which is about 6 miles, and greatest breadth, 1½ miles. During Quaternary times it was an island, but owing partly to an elevation of the coast, and partly to the detritus brought down by the San Diego River, it becomes joined to the mainland. It rises 400 feet in almost perpendicular cliffs at its southern end, gradually lessening in height toward Old Town. The rock of which it is formed consists of soft shales and sandstones, the latter often quite consolidated. The strata at the extreme end of the point dip south, but in a short distance turn and maintain a quite

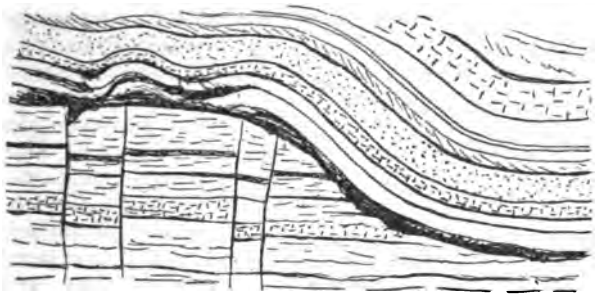


Fig. 12.

uniform dip to the northeast nearly the whole length of the peninsula. This abrupt elevation evidently owes its origin to a fault accompanied by an uplift, and not to erosion. Beginning at Ocean Beach, and following along the base of the cliffs to the light-house, hundreds of faults can be counted. Near Ocean Beach fifteen can be counted in the space of 200 feet. The direction of these faults is nearly at right angles to the strike. The most of them are nearly vertical and clean cut. The throw varies from a few inches to many feet. Sometimes the north and sometimes the south wall has risen. An interesting overthrust fault is exposed in the cliffs north of Ballast Point. (Fig. 12.)

A conglomerate of late Tertiary age overlies the Cretaceous rocks unconformably on the extreme end of the point. These conglomerates are firmly cemented and form high cliffs. They dip at an angle of 30° to the southeast. The pebbles are in part derived from the sandstone of the point, and in part from the crystalline rocks east of the mesa. Near the top of this conglomerate are immense, semi-angular bowlders. These have rolled down to the beach and are strewn around the end of the point. Many large ones are to be found a little west of the new light-house, but the greatest of all is on the eastern side. It is fully 10 feet in diameter, and formed of the same kind of rock as that on which the mesa rests 8 miles east of San Diego, viz: a green volcanic tuff. It is a very interesting question as to how these immense bowlders have been transported so far and left in the beds near the top of the cliffs. I can account for it only by supposing that the point with relation to the country back of San Diego was several thousand feet lower at one time, and that a river of great volume, flowing over a steep channel, entered the bay at this place, depositing irregular beds of bowlders. This old river may have been the same one which formed the auriferous gravel channel before mentioned. The fault planes on Point Loma extend through the conglomerate beds, indicating that the elevation took place after the bowlder beds were formed.

An interesting collection of fossils was gathered from the lowest strata exposed, and from the bowlders in the conglomerates. This collection numbers something over sixty Cretaceous species, many of which are new. The fossils are not abundant, nor are they well preserved. Nearly all of these are characteristic Chico (Upper Cretaceous) fossils. There is, however, one species found here in considerable abundance, but rather poorly preserved, which Dr. White has described under the name of *Coralliochama Orcutti*, and which he has made the chief foundation for a new division of the Cretaceous, termed the Wallala Beds. The name

was given on account of the occurrence of this fossil, together with several other species, at or near Fort Ross, Sonoma County, and also at Todos Santos Bay, Lower California, where the best specimens were found. These beds stand in an unknown relation to the other Cretaceous deposits stratigraphically, but have been supposed, on account of the fossils, to indicate a division between the Chico and Shasta groups. I believe, however, that the occurrence of the most important fossil of this supposed division on Point Loma, in the same beds with undoubted Chico fossils, destroys the validity of the supposed Wallala Beds.

In a bluff at the northeastern end of the Point Loma peninsula, west of Old Town, there is a stratum of calcareous sandstone, carrying many fossils belonging to the Eocene, or lowest Tertiary. The strata dip northeast at a small angle, and though they cannot be traced continuously west to the outcrops of Cretaceous rocks, yet from the fact that they have the same dip, leads me to the belief that the two beds are conformable. This younger deposit corresponds to the Tejon, or Division B, of Professor Whitney. Everywhere in the State there exists the closest relation between the Chico and the Eocene. Here on Point Loma they are undoubtedly also conformable, but each is distinct as regards its fauna, for they are separated by nearly a thousand feet of unfossiliferous strata.

False Bay occupies the basin of a synclinal, for the strata dip northeasterly from Point Loma and south from the Soledad Hills. A violent disturbance, forming a great uplifted fold or perhaps a fault, has taken place along a line extending southeast from La Jolla through the Soledad Hills. At the eastern end of False Bay there is a small exposure of Eocene strata, dipping west. Near the mouth of Rose Cañon the strata dip southwest, and at the mouth of the cañon they dip 40° northeast. Along the road which leads over the hills to La Jolla the rocks are tilted at a very high angle to the southwest. The highest point of the Soledad Hills, rising 700 feet, lies over this disturbed region. Unconsolidated bowlder deposits lie on the top of the hills. The strata on the east side of Rose Cañon are well exposed, but do not seem to partake of the disturbance shown on the west. This is probably no unconformity, as they contain Eocene fossils, and the Eocene in other spots appears to be conformable with the Chico. Along the coast between False Bay and La Jolla the strata dip south at a small angle. At La Jolla, near the caves, they have been folded so as to dip very steeply to the southwest for nearly a quarter of a mile across the strike. Near the eastern end of the cliffs a reversal takes place, and they dip northeast at nearly as great an angle. Around the little bay there are no exposures, but a mile northward begins a very high line of cliffs, which extend through to the mouth of Soledad Cañon. This fold at La Jolla brings to the surface fossiliferous strata, bearing a number of species similar to those at Point Loma; among them is the *Coralliochama Orcutti*. The strata of the high cliffs north of La Jolla dip northerly at a small angle, and show only a few fossils of the Eocene age. The cliffs rise fully 400 feet. At the bottom of the cliffs are shales; higher up are great beds of conglomerate bowlders, chiefly a reddish porphyry.

Coal is reported to outcrop above the water at very low tide somewhere along this stretch of cliffs. It of course must occur in strata of Tertiary age. The coal vein struck in a boring at La Jolla must be Cretaceous. About 3 miles up the coast from La Jolla, there appears a dike of basalt cutting the Tertiary shales. At high tide it is nearly

covered by the ocean. It has a course about 30° east of north, and stands vertical. It begins on the north, close in under the high cliffs, but does not extend into them, the only signs being a fault in line with the dike. It is not more than 2 feet wide at the northern point where it is exposed. It is dark and compact and so decayed as to be easily taken for an argillite. The walls of the dike are very smooth and regular, except near the southern point, where it runs into the water. Here it swells to a width of 30 feet. The edges of the dike are compact, while the vesicular portion is in the center, where there is often a flowage structure developed. The central portion is more or less laminated parallel to the wall, and thus is generally a well-pronounced columnar structure developed the whole width. The columns lie horizontally across the dikes and are 12 to 15 inches in diameter. The cavities are wholly or in part filled with calcite. Metamorphism of the adjoining shales is apparent for 2 feet away, but the sea water has so decomposed the shale that it is not so strongly marked as it would otherwise be. The dike projects above the water in places for a distance of 1,000 feet, making its total exposed length about 1,800 feet. In the mesa southeast of Rose Cañon, and along the San Diego River, and back of San Diego, the formation belongs almost wholly to the late Tertiary. It is not certain whether the Miocene is present or not. A number of Miocene fossils have been found in the county, but perhaps the most of them have come from Carrizo Creek. Many fossils are given in Dr. Cooper's list, as being found in the Pliocene of San Diego, which are more characteristic of the Miocene in other localities. I see no reason for doubting that the Miocene is present, but so intimately related to the Pliocene as to be stratigraphically inseparable from it. In the region between Rose Cañon and the northern boundary of the county, I do not know that Miocene fossils have been found, but in Orange County they are well characterized.

The region occupied by San Diego Bay and the mesa back of it is composed, as far as we know, of Quaternary, Pliocene, and perhaps Miocene strata. Sandstones characterize the lower formation, and loosely cemented conglomerates, increasing in thickness toward the mountains, the upper. These were deposited in a sort of basin, of which Point Loma and the Soledad hills formed the northern and western borders. Many oscillations of level have taken place, the most recent being an elevation of 40 feet, shown by an old beach line on Point Loma. The shells in this beach are the same as those now living in the adjoining ocean. It is a peculiar fact that the mesas are slightly higher near their western terminations than farther east, indicating a recent uplift along the ocean. Water is scarce through this mesa formation. At the end of Point Loma there is a strong sulphur spring exposed at low tide. Its waters may possess medicinal properties, and should be examined.

On the southern shore of False Bay is a large deposit of calcareous tufa. The central portion is quite pure and a number of feet thick; just how thick is not known. It extends along the shore some distance, and often contains bowlders and shells. This is evidently a deposit from some former spring of great size. The mesas lying west of the extensive volcanic tuffs have been derived largely from the decay of the latter, and have heavier soil. North of Soledad they become more sandy, and maintain this character to the Santa Margarita Creek. This light soil, however, is being successfully cultivated in many places and for

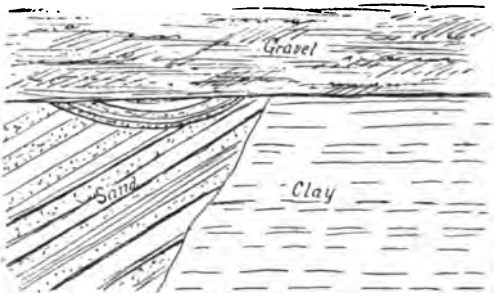


Fig. 13.

certain kinds of fruit, without irrigation. The surface of the higher portion of Point Loma, as well as some of the mesas north, is covered with spherical nodules, a quarter to half an inch in diameter, of sand cemented with red oxide of iron. These literally cover the ground in places so that it is difficult to walk. The origin of these at first seemed very puzzling, but on examining the face of a cliff on the top of which these were found, an explanation was reached. They were seen to grow smaller away from the surface of the ground until a depth of 2 feet was reached, when they cease. Their formation is due to the oxidation of the iron in the sandstone, and its segregation in little nodules on the same principle as the formation of concretions.

The cliffs of Eocene sandstone along the ocean grow gradually lower north of Soledad Cañon. At Encinitos the cliffs are higher again and for a short distance the strata dip south, but toward Oceanside they resume the northerly dip and disappear several miles south of that place. Faults grow less numerous the farther we get from Point Loma. The mesa is low about Oceanside; it was either never very prominent or else the erosion has been great.

On the north bank of the Santa Margarita Creek, near the ranch house, is an interesting cliff of Quaternary sands and gravel, showing a number of strata deposited under different conditions on an old beach. (Fig. 13.)

The Tertiary beds north of the Santa Margarita Creek are very different in outline from those south. Instead of their extending in a gradual slope from the older mountains to the ocean, there arises in them, near their western border, a range of mountains, known as the San Onofre Mountains. These extend parallel to the ocean at an average distance of 2 miles. They rise north of the Santa Margarita Creek and extend to the San Onofre Creek. They have a gradual slope on the west, rising to an elevation of 1,400 feet, but are quite abrupt on the east. Los Flores Creek cuts through the southern end of this range, showing that while the soft, clayey sandstones between it and the Santa Margarita Mountains slope only 5° to 10° southwest, the rocks of the range itself dip west at an angle of 35° to 40°. The formation is a breccia, the fragments of which are argillitic, micaceous, and hornblendic schists. Some of these fragments are of great size, one bowlder of hornblende schist being 8 feet in diameter. Pebbles of white quartz and other hard metamorphics are also present. The soft, coarse sandstone in which the fragments are imbedded show no traces of any granitic matter. The range was ascended 2 miles north of the Los Flores ranch house,

and found to consist entirely of fragmental schists, such as those mentioned, dipping southwest at an angle of 45°. The mountains were also climbed at their northern end, near San Onofre Creek. Here there is a very abrupt escarpment on the eastern side. The strata dip toward the ocean at a high angle, while the irregular hills and ridges of soft, light-colored sandstone lying east toward the Santa Margarita Mountains are nearly level. After a careful study of the range the conclusion was reached that its origin was due to a great fault, represented by the very abrupt eastern slope, tilting the elevated portion to the west at a high angle. I believe that this fault took place after the deposition of the Tertiary strata. As far as my observation went the Tertiary beds on the east do not rise to meet the San Onofre range, as they would to a certain extent if it were present when they were deposited; on the contrary, they dip toward it. West of the range the ocean is bordered by very high cliffs of Quaternary clays, and in only two or three places do the Tertiary rocks outcrop. Small patches of sandstone outcrop near the road at the western foot of the mountains; they also dip west at a high angle. Many of the fragments at the northern end of the range show their derivation from a massive crystalline rock. The hornblende schists are generally garnetiferous. Blue glaucophane schists are also very common. South of Mission Viejo Creek, Orange County, there is an outcrop of rock, apparently in place, which greatly resembles these schists. Good outlines of these mountains, indicative of structure, can be seen to great advantage from the San Luis Rey Mission. On the west slope of the San Onofre Mountains, 4 miles north of Los Flores, is an outcrop of a garnetiferous hornblende schist, which certainly appears to be in place. This rises 10 feet above the side of a gulch, and is fully 20 feet across. One mile north and in line of strike with the last is another outcrop of similar rock, which is so large that it certainly seems that it must be in place. The only point north of the San Onofre where this breccia appears is at Arch Beach, Orange County. The Santa Margarita Mountains are bordered by very extensive bowlder deposits, which rise as high as 1,500 feet on their western slope.

The topography of the northwestern part of the county between Temecula, Elsinore, and the ocean, is very complicated. This section is occupied by rugged, brush-covered mountains and narrow, deep valleys, with the exception of the Santa Rosa plateau, where the configuration of the county has been entirely changed by extensive lava eruptions, stretching over a distance of 10 miles. This mountain region narrows toward the north to form the Santa Ana range. The variety of rock formations is very large. The northern portion is unsurveyed. On the south are the two large grants, the Santa Margarita and the Santa Rosa. Between these lies De Luz Valley. The Santa Margarita Mountains extend north and south, forming the eastern borders of the grant and rising to an elevation of 3,100 feet. The granite of the region about De Luz Valley is far from being homogeneous. A part of it is undoubtedly intrusive, and a part may represent an original sedimentary formation. Bedding planes are present in much of this supposed metamorphic granite, but generally no schistose structure. The presence of the De Luz warm springs is perhaps due to a dike of dark, aphanitic diorite, which has cut through the granite in an irregular manner. A very interesting breccia outcrops in the bed of the creek below the warm springs. (Fig. 14.)

Fig. 14.

The fragments are chiefly granite and an aphanitic rock. They are quite angular, showing only a slight rounding of the corners. Some of the larger fragments are a foot in diameter. The boundaries are very irregular. Long arms of the inclosing granite project into the breccia. The base or matrix varies from a coarse syenitic rock to an aphanite. It often seems to present a blending of different kinds of fragments. Besides the large inclusions there are scattered through the matrix small angular pieces, which are so regular in outline and distribution as to give to the rock the appearance of a porphyritic structure. The granite in the hills west of the valley contains much biotite and quartz in long, rounded grains, presenting a pseudo-porphyritic aspect. This appearance is characteristic of much of the granite of this section. Imbedded in the granite are masses of dark aphanitic rock. The lower granite hills are covered with considerable sandy soil. There are isolated peaks of a coarse white granite, much like that of the Sierra Nevada, arranged in some sort of regularity in north and south lines. One rugged peak of this coarse granite rises 2,500 feet west of the valley. At the northern end of the valley the bedding planes in the finer grained granites are very regular; strike north 45° west, dip 65° southwest. There is, however, no schistose structure present.

A half mile above the warm springs is another conglomerate or tuff, which seems so related to the granite that the latter must really be eruptive. In a little valley southwest of De Luz and just east of the Santa Margarita grant there is a large outcrop of diabase. It has been intruded in a fine-grained, jointed granite. Farther down the valley, on the road to De Luz Station, there is a narrow outcrop of black quartz feldspar porphyry, followed on the east by a dark felsitic mica schist; strike northwest, dip 60° southwest. Immediately west of the deep cañons which lead down to De Luz Creek, rises the Santa Margarita Mountains. They consist of a fine-grained granite, verging at times on a quartz porphyry. The main crest is 2 miles long, the highest peak of which is nearly 3,200 feet. The rock is perfectly massive, but shows apparent bedding planes; strike north 30° west, dip 80° northeast. The porphyritic facies of this formation occur in the western slope. On the western slope of the main range, at an altitude of 2,500 feet, there is a plateau-like area of a thousand acres or more of fine grass land. It is

dotted with white oak trees. The western slope of this plateau is very abrupt and brushy. The formation is partly porphyry and partly dark diabase and diorite. The most interesting fact connected with the Santa Margarita range is the occurrence of sandstone at an elevation of 2,600 feet on its western slope. The sandstone occupies very limited detached areas in the heads of the gulches, and is evidently the remnant of a once far more extensive formation. The sandstone is largely kaolinitic, and has evidently been derived from the adjoining rocks. At the foot of the southern end of the mountains appears very quartzose rocks, probably of metamorphic origin. Coarse granite has been intruded into them in small bunches. Granite extends southwesterly in the form of a wedge as far as the Santa Margarita ranch house, and is there covered by modern deposits. Between De Luz and Fallbrook the country is gently rolling, with knobs of granitic rocks projecting here and there. About Fallbrook, and for some distance east, the granite does not outcrop much, owing to its easy decomposition. A little east of De Luz Station is a small body of mica schist; dip 30° east, strike north 15° west.

The road from Fallbrook to Temecula leads through a long, narrow valley. On either hand rise high mountains of bare granite. Immense bowlders, 20 to 30 feet across, line the valley, having fallen from the cliffs. The granite here is a coarse rock, rich in biotite, and though great masses could be obtained free from checks, yet does not seem durable. The valley owes its origin to a difference in rapidity of decay along certain lines. On this section there appears no trace of the schist belt extending northwest from Julian. This coarse granite is undoubtedly intrusive and has cut it off.

A wholly different series of rocks is exposed in the Temecula Cañon, not more than 2 miles north of the country just described. This cañon is deep and rocky, taking a very direct course from Temecula to the ocean. At the upper entrance there is a narrow exposure of granite. This is followed by quartzite, dipping 45° southwest. The rocks shortly become massive and are replaced by dark syenitic ones with an excess of hornblende. Two miles down, granite appears for a short distance, and in it a quarry has been opened. The rock can be obtained in blocks of any size from great masses which have broken off and rolled into the cañon. Gneissoid rocks soon replace the granite, and these are followed by hornblendic rocks, which vary from a schistose to a massive structure. In places they contain feldspar and pass into syenites; in others the rock is almost pure hornblende. The greater portion of these rocks are of metamorphic origin. The dip is generally vertical, strike east and west to northwest. The syenites are followed by mica schists, and these by coarse biotite granite about 5 miles above Howe Station. In the granite are many pegmatitic veins, carrying biotite, garnets, and tourmaline. Fine-grained granite, varying at times to syenite, forms the rock along the cañon for many miles below this point.

The most interesting geological feature about this northwestern part of San Diego County is the long plateau, confined chiefly to the Santa Rosa grant. This plateau lies near the western corner of the grant, and extends east nearly to Murrieta. The lava is broken up into detached tables by erosion, which become very strongly pronounced toward the western end of the flow. The western body of lava is the highest. It has a length of nearly 2 miles and is broken into three peaks or ridges, sloping generally a few degrees to the east; height

2,850 feet. There are two terrace-like tables lower down its southern slope. The lava is, perhaps, a hundred feet thick at its eastern end, and has been so much eroded toward the western portion that the underlying sandstone is exposed along the crest of the ridge, with lava lying in broken masses along its sides. The sandstones form quite an extensive bed under the lava flow, being 200 or 300 feet thick, and horizontally bedded, wherever bedding is present. The upper part is very soft and granular, the lower portion is hard and stained reddish. It carries many bowlders 6 to 8 inches in diameter, different from any other rock seen in the adjacent mountains: quartzite mica schist, aphanitic rocks, and some granitic ones. These are washed smooth. The sandstones contain much kaolinitic matter, and at one spot show an incipient crystallization. A number of contiguous grains, over a space half an inch in diameter, show the same orientation. Near the bottom the sandstones are impregnated with iron. The western ridge in particular shows a great amount of erosion. The lava is nearly gone in places, but occurs southward in scattered outcrops for half a mile. At the northern end the sandstone rises fully 300 feet above the lava. Lava is present on its sides. Much of the sandstone closely resembles a granite decomposed *in situ*. Fragments of the mica schist resemble that in the hills west of Temecula. Northward half a mile is the deep cañon of the San Mateo. The country descends very rapidly from the lava ridge, especially so on the north, where the cañon is fully 1,500 feet deep. It is a number of miles in any direction to mountains which are as high as this lava-capped sandstone ridge, and the amount of erosion must have been enormous since it was deposited. Mesa Redonda has an elevation of 2,750 feet, and is separated from the lava just described by a valley fully 800 feet deep, and nearly a mile broad. Mesa Redonda is formed by a lava table, probably basalt, 150 to 200 feet thick. It is quite precipitous on three sides. The lava is bedded, dipping 5° to 8° northeast. Underneath is a body of coarse, friable sandstone, similar to that just described. Some pebbles and bowlders of lava lie in the upper portion of the sandstone. The sandstone consists of angular quartz grains and kaolinic matter, and often presents the appearance as if it had been partly fused by the lava. In the top of the sandstones are pebbles of quartz, feldspar, and mica schist. The sandstone shows no bedded structure, but seems to form a mantle over the hill, following the irregularities of the underlying granite. It descends 700 feet on the southern slope of the mountains which rise so abruptly from De Luz Valley. The lava has spread out in thin sheets on the southern slope of the mountain, descending more than a thousand feet on the east side of Cottonwood Creek. These thin beds are not massive, but are formed of angular lava bowlders. The flows were so thin that they either broke up on cooling, or later through atmospheric agencies. Fig. 15 is a sketch of Mesa Redonda from the north.

Cienega Peak lies east of Mesa Redonda and is separated from it by two gulches opening in opposite directions. It has an elevation of 2,400 feet, and the mesas east rise still less. Sandstone underlies this as it does the other lava flows. Near the eastern end of the southern slope, a lava flow has broken out from a basin-like depression which opens southward, and flowed down the mountain for a mile, descending a vertical distance of 1,800 feet. It appears to have broken up entirely into angular bowlders. The stream was probably very liquid, like the

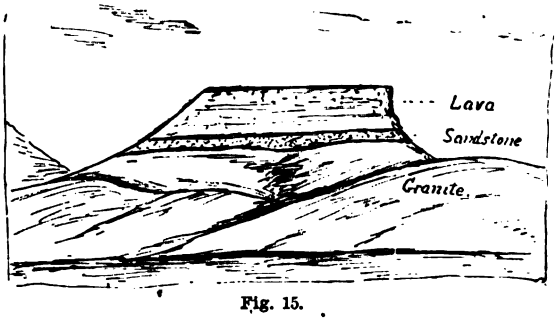


Fig. 15.

others, and formed a thin flow. It takes a slightly winding course and slopes often 30°. One short branch appears on the western side about half way down, and another on the east near the bottom. The lava descends in successive terraces, like steps, from the crater depression. The width varies from 500 to 700 feet, terminating in a straight line about a hundred feet above the bed of the cañon at the head of De Luz Valley. This distance may represent the amount of erosion since the stream flowed. There are also cañons worn to some depth on each side. The surface of the flow is rounding, and appearances indicate that it descended over a surface not much different from the one now shown. A large part of the bowlders in the creek for several miles are lava.

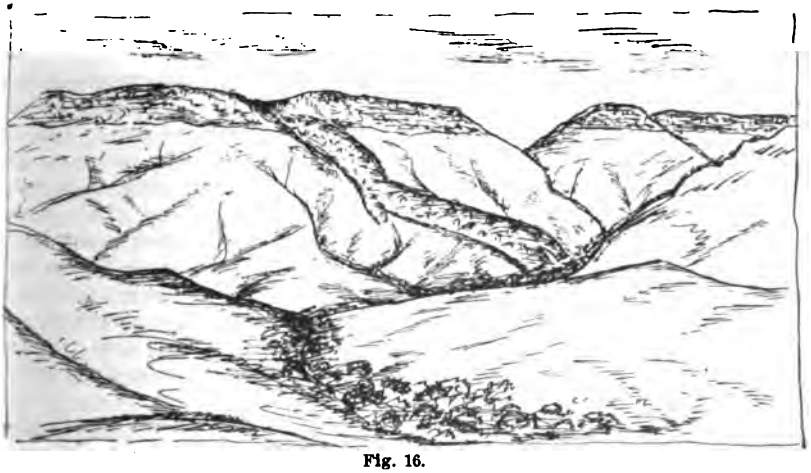


Fig. 16.

Fig. 16 shows this lava stream as it lies on the mountain side, and also Cienega Peak, from which it flowed. These lava beds appear very prominent from De Luz Valley. The long, winding flow is known locally as the Oak Ridge, on account of its being covered with oaks, while the adjacent mountains are barren and brushy. It is hard to reconcile the appearance of these isolated peaks, with often precipitous sides, and deep valleys between them, showing a great amount of erosion, with the thin sheets spread out on the southern side of the mountain in so many places, which from their position indicate so little erosion since

they flowed. It is possible that the mesas, with the high precipitous cliffs, represent remnants of an older flow, and yet the lithological character of the lava seems to point to a single origin. With the exception of the long southerly flow and another short one west of it. the lava everywhere presents bluffs on its southern side, with deep gulches between them. Toward the northeast and east there is a gentle slope. A large part is coarsely vesicular; dense massive portions are mixed irregularly in places with the vesicular. The lava tablelands lie nearly 2,000 feet above De Luz Valley. This abrupt escarpment extends east as far as the lava does, though less marked. There has either been an enormous erosion in the region lying south, or a great fault elevating the plateau. A detached portion of the lava plateau caps the hills west of Murrieta, extending in a north and south line for a distance of 2 miles. Whether these detached portions all had their source in one great flow and have been separated by erosion, or were formed from different sources, was not fully determined. It seems probable, however, that the main portions did belong to one flow, from the fact that they have a uniform slope and are underlaid by similar sandstone, which may once have been the bed of a stream.

The range of mountains lying west of the valley which extends from Temecula to Elsinore, also has the appearance of having been elevated by a fault. From the entrance to the Temecula Cañon, northward past Elsinore, and along the eastern base of the Santa Ana Mountains, these abrupt escarpments and indications of a fault become more pronounced. The eastern part of the Santa Rosa plateau, with its lava fields, forms the southern end of the escarpment. The valley in which are located the towns of Temecula, Murrieta, and Wildomar, rises gradually toward the east. The western portion is very fertile. Artesian water is found at Murrieta. The eastern portion, which rises toward the granite mountains, is more gravelly, while east of Temescal there is a stretch of many miles of these dry gravel hills, probably of Quaternary age. The town of Temecula has an elevation of 1,000 feet. Immediately west and north of the cañon there arise hills of metamorphic rocks, having an elevation of 1,800 feet. They are covered with dense brush on their eastern slopes, but contain some fertile valleys to the west. For several miles the rock is almost wholly matamorphic. It extends south to the cañon and north to the lava plateau. It is chiefly a fine, dark mica schist; strike indistinct but north 60° west, to east and west, dip vertical. On the west it changes to a quartzite. Dikes of granite cut this rock; one is noticeable for several miles by its more pronounced croppings over the hills.

East of Murrieta the granite begins near the boundary of the grant, and forms a line of barren hills extending northerly. East of these the country is less rocky and quite fertile. Many springs abound in the granite through this section. Near the Hot Springs is a dike of granite porphyry. Numerous bunches of a dark, coarse, dioritic rock are scattered through the light-colored country granite. They weather away more slowly than the granite. The metamorphic rocks of the Santa Rosa plateau extend north to the entrance to the cañon, up which the road passes to Parker Deer's. The strike in the cañon is a little east of north. The metamorphic rocks terminate in a range of hills which form the southern boundary of the Rinconada. Northward the country is formed of rugged granite mountains. The Los Alamos opens westward

into deep cañons, which lead down to the coast. A dark dioritic granite is included in the usual light-colored variety, sometimes in bowlder-like masses and sometimes in dike form. The metamorphic rocks extend 2 miles west of Parker Deer's house. They include mica felsite and dark vitreous quartzite. They are often intruded by granite bosses and dikes of quartz porphyry. The lava table-land lies just south of the ranch house. It is about 40 feet thick, and has underneath a kaolinic stratum 12 to 14 feet thick, which is impregnated with bog iron; one assay has shown 10 per cent. This is quite similar to the sandstone under the table-land farther west, but is less quartzose. A similar deposit, impregnated with iron, was seen north of Mesa Redonda. The Santa Rosa grant consists chiefly of broad, open valleys, having an altitude of 1,700 to 1,800 feet, with rocky ridges between them.

On the trail from Santa Rosa to Howe Station, the metamorphic rocks extend to within a mile and a half of the latter place. They are chiefly light-colored, granular quartzites. Dikes of diabase and gabbro appear in many places on the Santa Rosa grant. Ores of gold, silver, and copper are found in the metamorphic rocks of the grant, but they have never been developed. Selected samples of galena assay several hundred dollars to the ton in silver. The veins are, however, small and bunchy, and it is not probable that they can be profitably worked. The granite varies from one with mica, as the only dark constituent, to one with much hornblende. It is uniformly coarse and of undoubted eruptive origin, judging from the manner in which it has broken through the metamorphic rocks.

The table-land west of Murrieta is about a mile broad and fully as high as that near Parker Deer's house. It is separated from the lava farther west by a mile of brush-covered hills. The lava was supposed to extend no farther than the big cañon west of Murrieta, but a close examination revealed a small outcrop on the hills about a mile south of Wildomar. The elevation is about 600 feet above the valley. It is perhaps one fourth of a mile across. In places it extends down the hill nearly one third of its elevation above the valley. It presents the appearance of having flowed out of the summit of the hill when it had much the same form as now, and down over its sloping surface. This eruption is fine-grained, and not vesicular. Much of it has a conglomeritic character, appearing to have been broken up when almost solid, and then cemented. The fragments are more or less rounded and elongated, and are at times almost blended in the matrix. There are signs of former solfataric action on the summit, there being a considerable deposit of a light yellowish material, consisting chiefly of alumina and magnesia. Under the lava is sandstone 10 to 20 feet thick, composed of quartz grains and kaolinic matter, exactly similar to that under Mesa Redonda. It would be easily taken for granite decomposed *in situ*, but for the large quartz grains. The sandstone has an apparent southerly dip. It is very difficult to account for the presence of the sandstone under the lava, unless we suppose it covered the adjacent country, and was only preserved by the greater permanency of the lava. Another hill of lava was found 200 feet lower, about a mile south of this, and west of the cañon leading up to Parker Deer's. It occupies a sort of depression between three hills, with gulches cutting into it between them. The lava is very similar to that just described.

A long, high ridge running northwest and southeast, adjoining the

lava, is very interesting. It is about 200 feet higher, and covered with dense brush, as is all the country in this vicinity. The greater part of the hill is formed of a coarse tuff, whose fragments stand out in sharp relief on the surface of the huge projecting, bowlder-like masses. The matrix, which is darker and softer, weathers out, leaving the surface of the rock covered with a great variety of fragments. Some are scoriaceous or amygdaloidal, others are very coarsely crystalline and porphyritic with feldspar or hornblende. Some of the fragments are themselves tufaceous, containing large masses of hornblende in a dioritic matrix. On the southern end of the hill, a great variety of dikes intersect the tufa. This is in all probability the neck of an old volcano, but appears to have no relation to the modern lavas near it. Owing to the exceeding difficulty of traversing these hills, the exact relations of the formations were not ascertained. About 10 miles east of Temecula, near the point where the creek takes a turn to the southeast and enters a cañon, there has been another lava eruption, but the time at my disposal did not permit me to examine it. A great variety of rocks are exposed along the road from Elsinore to Menifee Valley. For nearly 2 miles east of the station the rock is a white, glassy diorite, with an excess of feldspar. At the point where the road crosses the railroad, metamorphic schists appear. The rock is a fine, dark mica felsite. It is so compact that it breaks with a conchoidal fracture. A great irregularity in strike and dip exists; the average strike is a little west of north, dip northeast. As far as the top of the grade, the rocks are in part metamorphic and part dioritic. There are many dikes; some fine-grained granites, others micaceous diorite porphyrites. The hills along the west side of Menifee Valley seem to be mostly metamorphic, with some bunches and veins of granite.

All of the mountainous region lying south of the road from Temecula to San Jacinto is granite or diorite, excepting a strip of micaceous schist and gneisses near Glen Oak Valley. These strike northwest toward Menifee.

No opportunity was given me to examine the mountainous regions comprised in the San Jacinto range. The line of hills lying northeast of the town and having a northwest direction are composed largely of gneiss and mica schist, with some bodies of white crystalline limestone. In the line of strike these hills finally disappear north of San Jacinto Lake, under Quaternary clays and gravels, which form rather an abrupt rise from the San Jacinto Valley and extend northerly to the San Bernardino Mountains. The deposits show a great deal of disturbance. A part of them may be Tertiary. Dikes of dark, heavy diabase and diorite are common about the sulphur springs north of San Jacinto.

The hills for a distance of 3 miles north of Elsinore are formed of slate and mica schists; strike north 70° west, dip vertical to 45° east. This is a continuation of the same series of rocks exposed on the road to Menifee. A lenticular body of limestone occurs in these slates about 3 miles north and east of Elsinore. It is highly metamorphosed, has a gray to dark color, and is traceable for 500 or 600 feet. At one spot a stratum of quartzite divides it. It was carefully examined for fossils, but none were found. About 4 miles from Elsinore granitic rocks appear, followed by dark diorites in the vicinity of the Good Hope Mine. The Pinacate district, taken as a whole, is rather peculiar. At first sight it seems to be formed of granite, dark diorite, gneiss, mica schist, and other metamorphic rocks, arranged in the most

irregular manner. The belt of metamorphics northeast and east of Elsinore is terminated on an irregular east and west line by these granitic bodies, which inclose portions of the schists, and extend into the main body as long, dike-like arms. In the vicinity of the Good Hope Mine the strata of metamorphic rocks inclosed in the granitic rocks have a north and south strike, and are traceable for a mile or more. The veins of the Good Hope Mine are in a dike of light-colored biotite granite. It has considerable width on the surface, 100 feet or more, but below ground some distance it is not over 12 feet. On the surface it is greatly decomposed and cut by numerous small veins, which are so scattered that they hardly pay for working. Below they unite to form larger veins, generally one on the foot and another nearer the hanging wall. The latter is more irregular, often running out at a small angle. The foot wall, a dark compact diorite, is very regular. The walls are separated by well-defined clay seams from the vein matter, the decomposed granite. Clay seams also separate the different veins. The foot wall diorite forms the country rock indefinitely eastward. The hanging wall is a fine, dark brown mica schist. The quartz is generally friable, and the granite vein matter much decomposed. The quartz at a depth of 300 feet carried one third of the gold in the sulphurets. A small amount of silver is also found. This vein is located for over a mile; direction a little east of north, dip 65° west. It is remarkable that there is no barren quartz; all the ore pays for working. In the lower workings the veins become more regular.

The Good Hope is the first mine in this district to reach a paying basis, and that has succeeded in finding a regular, defined quartz ledge. About 3 miles northwest is another vein, which has an east and west direction. It seems to lie wholly in granite, save for a narrow stratum of mica schist on one wall. The vein is located for a mile, but no extensive development has yet been made on it. On the hills, a short distance southwest, is an old Mexican mining camp. Many small veins are found in the vicinity, generally in a dark micaceous diorite. There are also bunch-like masses of coarse white granite, blending into gneiss and the gneiss into mica schist. The strike is exceedingly irregular, changing from north and south to east and west in the course of a few feet. Toward Elsinore mica schist, quartzose, and feldspathic rocks replace the greater portion of the granite. For some distance the schists are cut up by dikes of fine-grained granite, running in different directions, and small bunches of the same rock, often only a few feet across, but sharply differentiated from the schists. Judging from the exposure here, I think we might say that at the time of the metamorphism the action was so intense as to change the sedimentary rocks to mica schists and gneisses and through these to squeeze the liquified portions of the same formation in dikes and fissures. Small fragments of mica schist were noticed in the eruptive masses. In a region like this it is often difficult to draw the line between eruptive and metamorphic rocks. It has been shown before that lamination is no sure indication of sedimentary structure.

Lake Elsinore is bordered on the west by a high and rugged granite range. In the mountains west of Elsinore the granite which cuts off the metamorphic rocks on the Santa Ana range is again replaced by the Metamorphic Series, which are here very greatly altered. They strike a little west of north and dip vertical or at a steep angle to the east.

The boundary of the granite is very irregular, and masses outcrop in the metamorphics near the main contact line. Much of this crystalline rock perhaps more truly belongs to the diorites.

The new silver mines lie just north of the San Diego County line, and west of the divide, a position which brings them into Orange County. The formations in which the veins occur vary from a dark brown felsite, often micaceous, to a finely banded quartzose rock. The latter is very compact, and often almost massive. In places hard, blocky argillites appear. The two or more veins found here carry galena bearing silver, and also much magnetite and iron sulphurets, with some of the baser metals. The veins are characterized by a dark red gossan cap on or near the surface. Carbonates are found in this. These deposits exist as impregnations along a fissure, which is not very strongly pronounced. The ore is usually quite massive. The little gangue present is calcite. Not enough development has been made here at the time of my visit to show how extensive the deposits are. The metamorphic rocks extend north along the mountains, forming the summit and eastern slope for a number of miles. Granite borders them on the west toward San Juan. It is probable that this belt of mineral-bearing rocks runs continuously through to Silverado Cañon. At some time this Elsinore basin opened out through the Temescal Valley, but now a low divide separates it from the head of Temescal Creek. Gravel-topped hills lie along the mountains west of the creek. At the terra cotta works a drill was sunk over 600 feet without reaching the bottom of the basin. The Cheney Coal Mine is located 5 miles northwest of Elsinore, in the same basin. The beds dip to the west and southwest, having clay below, and sandstone followed by clay above. The coal is 7 to 8 feet thick, generally solid, but in places showing a parting in the middle. A great deal of faulting has taken place, but there seems to be no system about it. The throw of the faults sometimes amounts to 30 feet, often disturbing the pitch of the vein, and making it greater. The strata evidently belong to the Miocene-Tertiary, for a little farther down the valley fossils of that age are found. This old Tertiary valley, undoubtedly an arm of the sea, opened into the large valleys of San Bernardino and Los Angeles Counties, and extended southerly to Temecula; though south of Elsinore the Tertiary is covered by Quaternary gravels. The depth is unknown, but the width is quite narrow, being from 1 to 2 miles. Not more than a quarter of a mile northeast of the coal mine the metamorphic rocks, quartzites, and hard, blocky argillites outcrop. East of Temescal Creek northward the mountains are formed of a quartz feldspar porphyry of a dark gray color; at times it blends into portions not distinctly porphyritic.

Three miles north of the San Diego County line granite appears again on the east flank of the Santa Ana range and extends north to Cold Water Cañon. Between Temescal Creek and the mountains is a broad, sloping gravel and bowlder deposit of great thickness, resting on the Tertiary. Two miles south of the Temescal Post Office there is an outcrop of soft sandstone carrying Miocene fossils. It dips southwest at an angle of 30°. Extensive clay banks of various colors and nearly horizontally bedded lie along the flanks of the mountains both east and west of the creek. An interesting series of rocks is exposed up Cold Water Cañon. This cañon has been eroded near the northern termination of the granitic portion of the Santa Ana Mountains. The first rock exposed is a mica-

ceous diorite, decomposed to a great depth, but very tough when fresh. This is followed by syenite. A mile up the cañon, near the western edge of this rock and wholly inclosed in it, is a small mass of jasper schist and a lenticular body of semi-crystalline limestone. No traces of fossils were found in it. West of the syenite is another diorite dike. Then follows banded jaspery rocks, sometimes verging on micaceous felsite or quartzites. There are also some slates, and all are often greatly contorted; strike north to northeast. North of the cañon these rocks extend to the summit, while south the Santiago Peak, the highest of the range, and the ridges leading up to it from the east, consist of a coarse quartzose granite, with but little if any triclinic feldspar. A variety of dikes occur near the the summit north of the cañon, among them hornblende porphyry, porphyritic granite, and syenite. Fossils were found on the ridge leading up to the summit, north of Cold Water Cañon. They occur in a grayish rock, apparently a fine micaceous felsite. They are poorly preserved, on account of the extreme degree of metamorphism to which the rocks have been subjected. The rocks have become so altered by pressure that they will not break on the lines of bedding, but perpendicular thereto. The fossils consist of impressions of a small bivalve shell. Only about a dozen specimens could be found. The rocks are more altered than any others I have ever seen carrying fossils. These are the first fossils reported from the metamorphic rocks of the Santa Ana range. These fossils when determined will give a clue to the age of the metamorphic gold-bearing rocks of this portion of the State, and also of the granite, concerning which much diversity of opinion has existed.

Dawson Cañon, which heads in the Temescal Mountains, was explored and found to contain interesting geological features. A fine opportunity is given for the study of the relation of the granite to the extensive porphyry intrusives. For 2 miles east of Temescal Creek no eruptives appear; the rocks being wholly of the Metamorphic Series, with exposures of highly altered sandstones, clay shale, conglomerates, etc., striking northwest and dipping southeast at 45° to 50°. About 3 miles up the cañon the argillaceous rocks are replaced by a coarse granite, rich in mica and quartz. This is the prevailing rock up the cañon for 2 miles, and it apparently extends much farther east. It shows a great variation in appearance; much of it contains large crystals of flesh-colored orthoclase. In this granite, particularly on the north side of the cañon, there are dikes of many kinds of rocks. Large dikes of beautiful diorite porphyrites, both light and dark colored, appear in places. At one spot 4 miles from the mouth of the cañon, there are rectilinear dikes of fine-grained granite, intersecting each other like artificial stone fences. For the distance of a mile east, after the granite begins in the cañon, the hills north show nothing but metamorphic schists. The porphyry in the mountains south does not reach the cañon. The great mass of this rock is dark, but in the vicinity of the granite it is lighter colored and more feldspathic, sometimes assuming a granitic structure. In places it is a gray, hard rock, of almost conchoidal fracture, and faint feldspar crystals. The granite near the contact is usually sharply defined, and has a faintly porphyritic appearance at times. The line of junction of the two formations is sharply defined, not only lithologically, but physically. It is difficult to say which is the older. No granite appears in dikes in the porphyry, but there are many dikes of a porphyry-like

appearance, resembling the light-colored porphyry in the granite itself. The line of junction is very irregular, and it is certain that the two formations do not belong to the same eruptive mass.

East of the head of Dawson Cañon there is another outcrop of considerable extent of metamorphic rock, micaceous felsites, and other dark schists. A mile west of the Gavilan Mines is a high conical peak formed of coarse, dark diabase. The mines of this district are in white biotite granite, continuous with that of the Pinacate district. The metamorphic rocks south of Dawson Cañon strike east and west, dip north, and extend in a westerly direction nearly to Temescal Post Office. North of the cañon, 2 miles from its mouth, there are a number of outcrops in vein-like forms and in bunches, of a black crystalline material, evidently tourmaline, identical with that at the Temescal Mine. These occur in the metamorphic sandstone and shales. The next large cañon in the Santa Ana range north of Cold Water Cañon shows highly disturbed Tertiary strata at its mouth, dipping away from the range at a high angle. They are soft, white clayey deposits, containing small nodules of selenite. The first of the older rocks exposed in the cañon is a hornblende porphyry, with variations to a granular diorite. For 3 miles up the cañon the only rocks seen are crushed and silicified ones of the Metamorphic Series. They dip, as a usual thing, at a high angle to the east, though in spots it is to the west or horizontal. Quartzose sandstones prevail, with blocky argillitic rocks and conglomerates. Near the summit there are dikes of green tufaceous porphyries.

Temescal Valley is underlaid by clays of a great variety of colors. They are being used very extensively for the coarser kinds of pottery and drain pipe. The Miocene deposits of the valley dip westward from the Temescal range, and instead of also dipping away from the Santa Ana Mountains basin-like, they dip west into the latter range. The dip of these beds 3 miles south of South Riverside is 5° to 10° southwest, and as the Santa Ana Mountains are approached the dip increases, and at a distance of a fourth of a mile, up to the metamorphics, it varies from 45° to vertical. The strata are not exposed all the distance across the valley, but there is no sign of a fold or overthrow; everything seems to point to a gradually increasing dip. This is indicative of an elevation of the region toward Temescal, or a sinking of the Santa Ana Mountains. This is undoubtedly the fault line which follows the range for such a long distance south. Several thin seams of coal outcrop for a distance of 10 miles along the base of the mountains. They have been opened in a number of places and all the strata found dipping into the mountains. The coal seams are often only a few hundred feet away from the metamorphics, and dip toward them at a very regular angle of 45°. Judging from the position of the strata it is not probable that the coal underlies the valley, and as it is so close to the mountains, formed wholly of rocks of the Metamorphic Series, it cannot be of great extent. I believe that appearances point to the whole of the coal beds having been eroded, save the limited, steeply inclined portion at the foot of the mountains. A crowding of the strata against the mountains during the movements along the fault line, have given rise to the steep dip. The highest portion of the Tertiary beds has an elevation of 1,500 feet. A very even, gently sloping plain extends from this elevation toward South Riverside. It is formed of unconsolidated wash from the mountains, deposited on and dipping in the opposite direction from the Ter-

tiary. The Tertiary formation consists of clays in various conditions of consolidation, others chalky in appearance, and a great thickness of argillaceous quartz-sand loosely cemented. Poorly preserved fossils are found in places. Near the southeastern corner of Mr. Hoag's ranch is a hill with hardened concretionary sandstone outcropping around it. Nearly every portion of this contains fragments of bones supposed to be cetacean. Artesian wells are obtained near Temescal Post Office at a depth of 300 feet. The water is abundant and of excellent quality, and is flumed to South Riverside.

Bunches of granite outcrop in the metamorphic rocks along the east side of Temescal Creek north of Dawson Cañon. At the dam of the San Jacinto Company there is a large outcrop of the beautiful diorite porphyrite, similar to that seen in Dawson Cañon. This extends northwesterly along Temescal Creek toward South Riverside, where it is quarried. It makes an excellent and durable building stone, being compact and free from much mica or hornblende. West of this is a narrow strip of coarse granite, followed by diabase. North of Mr. Hoag's ranch, and west of the dam, is a dike of black porphyry. Westward the crystalline rocks are overlaid by the Tertiary.

The dam commenced across the Temescal Creek at this point, where it enters the cañon, was intended to have been extended down to the bedrock, and thus bring to the surface the water which flowed beneath the surface channel. The diorite porphyrite is followed on the east by black porphyry.

Geology of the Temescal Tin District.—The Temescal Tin Mine is located in the northern part of the San Jacinto grant, and about 5 miles southeast of South Riverside. This portion of the grant consists of rolling hills. On the west is a large body of porphyry, extending nearly to the Temescal Creek.

The first rock exposed along the road to the mine east of the creek is a dark flinty one. This is followed by a body of black porphyry, with white feldspar crystals. The porphyry is about a mile across, and is followed on the east by massive black crystalline rock, and that by a felsite. These rocks are soon replaced by granite, in which there are dikes of fine-grained, highly quartzose granite. Little black veinlets of tourmaline aggregates are very numerous in the granite, extending through all the rock up to the porphyry. They have a northeast direction. The material forming them is the same as the gangue of the tin veins. A half mile south of the road is a cañon. Here the porphyry is seen extending up to the granite. The granite is greatly broken near the contact, and though there is no blending of one into the other, there is a confused mixture of broken portions of both rocks. Bunches and dike-like bodies of granite are inclosed in the porphyry. The little veinlets of tourmaline seem to have replaced the feldspar and mica, leaving the quartz. These veins grow larger toward Cajalco Hill. Just west of the works is a great mass of the black veinstone, the gangue of the tin ore. This rises in high, rugged croppings, and covers an area of about 300 by 250 feet. This is the greatest body of vein matter to be seen in the district. The tin deposit worked lies in an eastern prolongation of this cropping. The course of the veins is north 45° east, dip 65° to 70° northwest. The country rock is a coarse hornblendic biotite granite. The vein has the usual character of mineral deposits, swelling at times to a width of 8 feet, and then contracting to much less. The highest grade ore is found in

the narrower portions, where it is sometimes almost pure tin oxide, running as high as 70 per cent. The vein matter does not consist wholly of tourmaline, but contains quartz grains scattered through it in about the same porportion as in the granite. The tin is not found in the quartzose part of the gangue to any extent, but in the irregular vein-like deposits of pure tourmaline, which lie in the quartzose gangue. The tin occurs in this in bunches and stringers of nearly pure ore, or disseminated through it. This is particularly the case where the width of the vein is 6 to 8 feet. Where it pinches, the whole vein is sometimes formed of the tourmaline aggregate and tin ore. The vein has usually clay seams on both walls; sometimes it is frozen to one wall; wherever the walls come together and cut out the vein matter, the seams remain. The tourmaline vein matter is an aggregate of needle-like crystals. There are two varieties of tin ore: the yellow, appearing in thin layers in an uncrystalline form; the brown, in granular form in the massive specimens, or in small, clear, reddish brown crystals lining cavities. In the latter case it forms handsome specimens. A small amount of arsenical pyrites is present in places in the vein, and iron pyrites in the granite. The quartzose portion of the vein matter often blends into the granite walls, and there are bodies of evidently granitic origin wholly inclosed in the vein matter. A careful study of the vein matter, and its relation to the walls, shows that it is simply a portion of the granite, in which the feldspar and dark silicates, hornblende, and mica have been removed and tourmaline substituted. The quartz has the same character and color as that in the granite, and many transition stages in the process are shown. Where the action has been more intense, near and along the fissures, the quartz has been wholly removed and the tourmaline deposited, together with the tin. Cajalco was the center of this action. The veins decrease in size farther away.

At the time of my visit the mine had been opened to a depth of 180 feet, by two working shafts. The total length opened on the vein is 300 feet. Two levels have been run and work was in progress on the third. The main ore body lies in the center of the workings, and extends downward in the dip of the veins. The ore milled averaged 5 per cent of tin oxide, though large portions, as before stated, are very high grade. The company has also prospected Cajalco Hill by tunnel and open cuts, and one or more of the veins south by shafts. At the time of my visit two of Husband's pneumatic stamps were in operation. They weigh 900 pounds each, and drop one hundred and thirty-five times per minute.

South and southeast of the works are many bunchy veins of the black tin gangue. They often carry considerable iron. They extend, generally nearly parallel, in a northeast and southwest direction. Some appear as mere bunches on the surface. These veins closely resemble the main vein at Cajalco Hill, and are due to the same action, and it has been supposed that many of them will be found to carry tin, though it is not present on the surface. About 2 miles south the granite is replaced by a banded feldspar porphyry. This cuts off the tourmaline veins. The granite about the works, and especially toward the contact with the porphyry, is cut by many dikes of a fine-grained granite, having an excess of quartz and feldspar. Associated with the porphyry are strata of metamorphic rocks, of a hard, dark, quartzose character. A quarter of a mile northwest of the mine is a bunch-like outcrop of porphyry, carrying silver and copper carbonate. The black veins outcrop for a

distance of 2 miles northwest from the mine, extending into the porphyry, which replaces the granite in that direction. The granite extends eastward for many miles.

The general geological features which obtain here are: A semi-circular area of granite over 2 miles in diameter, surrounded on the northwest and south by porphyries and joined on the east to a great body of granitic rocks extending indefinitely in that direction. Around the border of this granite protuberance are many dikes of a fine-grained granite. Cutting through the granite in a northeast and southwest direction are the black tourmaline veins, which form the gangue of the tin ore when it is present.

Tin occurs here under conditions different from any other known deposit. Tin veins are almost always found in granitic formations, but such an extensively developed tourmaline veinstone is remarkable. The direction of the fissure system shown here is an uncommon one in California. The veinstone, together with the associated metals, has probably resulted from a process of sublimation along lines of fracture, removing those portions of the granite easily affected, over a large area, as at Cajalco Hill, and in the immediate contact completely replacing it with the massive aggregate of minute tourmaline crystals.

Thanks are due to the manager, Captain Harris, for the facility freely afforded me for examining the mine, the works, and the country about.

North of South Riverside the Tertiary beds dip at a small angle to the north. The Santa Ana River has cut its course through the hills at the northern end of the Santa Ana Mountains. No outcrop of the metamorphic rocks appears in the cañon. The Tertiary strata no longer dip toward the west, but in the Chino hills north of the river show a great anticlinal arch. Along the south side of the river the beds dip 70° northeast; farther west, near the heart of the range, they dip 60° southwest, strike north 30° west. Near the upper end of the cañon there are fault lines dipping toward the range, which show an elevation of the hanging wall. Bedrock Cañon is the first large one which opens to the Santa Ana River from the western slope of the mountains. Opposite the mouth of this cañon the greatest amount of water appears in the bed of the river, indicating the presence of hard rock only a little distance below. Coal veins are located near the head of this cañon, one 700, the other one 1,300 feet above the river. They dip only a few degrees to the southwest. They are exposed on cliffs facing the mountains to the northeast. Below them are very hard sandstones carrying fossils, probably Cretaceous. One prospect shows a number of seams within a width of 8 feet. The widest is 29 inches, the others much smaller. The other prospects show only one 39-inch seam. Their position, lying so flat high on the mountains, indicates an uplift without great disturbance, while the gypsum mines farther down on the flank of the mountains dip at a high angle to the southeast. It may be that all of the coal deposits of the western slope of the Santa Ana Mountains belong to the Cretaceous, and have been greatly separated by faulting and folding. A deposit of white, granular gypsum has been opened in Gypsum Cañon, 2 miles south of the river. The beds have a thickness of 8 or 10 feet. At one spot a large mass of crystalline dolomite was found. The deposits run with the strata, north and south, and dip west 60°. As we approach Olive, the few croppings seen still dip south or southwest, but at a less angle. South of the mouth of

Silverado Cañon a line of hills extends north and south, bordering the Santa Ana Plain. The western portion of these hills is formed of basalt considerably decomposed. The basalt varies from scoriaceous to fine-grained and compact. Its eastern edge was seen to rest on Miocene sandstones, and it dips west at a small angle, perhaps 10°. The lava seems to have been squeezed up in fissures, judging from the way in which it outcrops. Its greatest elevation is 800 feet. At some places the sandstones, where not covered with lava, have been silicified, turned to quartzite, or rendered granitic in appearance. This may be due to an intrusive neck of lava, or more probably to the action of thermal springs.

An interesting fold of the Tertiary strata was observed at the entrance of Santiago Cañon. The sandstones and conglomerates on the eastern side dip to the northeast at an angle of 30°, while those on the west side dip in the opposite direction. The valley has been eroded in the summit of an anticlinal. The rocks of the eastern side rise again against the side of the mountains, thus forming a synclinal. Up the cañon the sandstones on the west maintain a southwest dip of 45° to 50°, and strike north 40° west. The cañon finally leaves the anticlinal, and the rocks dip southwest on both sides. Toward the summit of the hill, north of the Harris Coal Mine, the dip increases to 70°, but on the top they turn so that the strata lie horizontal. Here they consist of clay shale. The strata at the coal mine swing around, and one mile northeast they strike north and south and dip west. This hill seems to form the southern termination of the anticlinal ridge north of Santiago Cañon. Southeast of this point there is a simple monoclinal fold or slope away from the older rocks of the high mountains. There has apparently been a fault extending northwest in this anticlinal ridge, bringing up the clay shales which farther south were shown to belong to the Cretaceous. Harris Coal Mine shows a seam 18 inches wide, shale forming the foot wall and sandstone the upper. There is a fault of 200 feet cutting this coal seam. The sandstone at the mouth of Silverado Cañon dips south 30°, forming bold cliffs. A half mile up the cañon there are heavy beds of clay shale inclosed in the sandstone. Cretaceous fossils appear in the shales, as well as in a coarse sandstone which underlies them. This sandstone is replaced by conglomerates near the contact with the underlying Metamorphic Series. The sandstone rises to a height of 2,500 feet, with bold, almost perpendicular cliffs facing the mountains. Portions of the sandstone containing the fossils are often very much hardened.

The first crystalline rocks met are dark and fine grained, with traces of bowlder-like inclusions, and are evidently eruptive tuffs. Above these are green, dioritic rocks. These intrusives are followed for several miles by sandstone and shale, in which the stratification is often obliterated. In other places thin layers of sandstone and shale are wonderfully contorted. The dip is at a high angle either east or west. In the vicinity of the old Silverado Camp there are dikes and bunches of a green dioritic rock. The mines in the Silverado district are again being developed to some extent. The mineral belt is about 2 miles wide, and extends nearly north and south. The country is formed to a great extent of dikes of greenish to blackish rocks, often showing distinct hornblende crystals. The dip of the metamorphic rocks is east about 45°. There is one main mineral vein located, beginning about a mile

north of Silverado, and extending in a southerly direction for 7 or 8 miles. The Quincy Mine is one of the most northern ones. The vein has a width of 2 feet; the ore, silver-bearing galena in a calcite gangue. It carries but little base metal of any kind. The ore has a peculiar appearance, the galena being distributed through the gangue in little leafy crystals or aggregates. The fissure is well defined and regular, with a pale green syenitic rock on the hanging wall, and a dark diorite on the foot wall. This hanging wall rock weathers to a light gray color, producing a rock known as porphyry among the miners. South of this mine a side vein carries much antimony. The Quincy has been opened along a length of 500 feet. The ore is quite uniform, producing one eighth in concentrates. The Quincy camp has an elevation of 2,300 feet. South of Silverado Cañon, in Silver and Pine Cañons, a great amount of work was done during the former excitement. The sides of the steep, rocky cañons are fairly honey-combed with tunnels, which were undertaken without sufficient prospecting, and, of course, never struck anything. The New York Mine spent much money, but did not prove a success. West is the Princess, and farther still, about 1,200 feet above the cañon, is the Blue Light Mine, on which much work has been done and rich ore taken out. The mines south of the cañon are in a feldspathic rock, which weathers white. It is undoubtedly an intrusive porphyry, for traces of feldspar crystals are to be seen. The mines are characterized by a large amount of zinc-blende, iron pyrites, and not a large percentage of lead, making them more difficult to reduce. The porphyry is mineralized in many places where no traces of the precious metals occur. Litigation and poor management seem to be the chief factors in stopping work in this district. Though some of the ore runs into hundreds of dollars to the ton, the most of it is medium to low grade.

About a mile and a half down the cañon from the old Silver Post Office, and in a cañon coming in from the south, is a cropping of dark, somewhat argillaceous limestone inclosed in shales. The limestone does not seem to have been highly metamorphosed, yet the fossils which it contains are almost obliterated. The faint impressions are those of coral stems, stromatopora, and some other low forms of life. Half a mile farther down the cañon is a cropping of brecciated marble. At many points, particularly on the north side of the cañon, there are great masses of apparently conglomeritic character, but with a crystalline structure. The matrix has a green to brown color, and in it are imbedded pebbles of the same degree of fineness, but often distinguished by much brighter red, purple, and green colors. In this cañon, as in others of this range, the water holds much lime in solution, and extensive tufas are frequently to be seen. The basal members of the Cretaceous at the mouth of Silverado Cañon consist of conglomerates passing up into sandstone, and those into shales; dip 55° away from the mountains in the highest ridge, but in the course of a quarter of a mile becoming much less. The change in dip is very sharp, giving the appearance of a fault.

A cañon which enters Silverado Cañon from the northeast near its mouth was followed up nearly to its head for the purpose of investigating some limestone outcrops. The first outcrop in this cañon is the usual dark porphyry. Beyond this the stream has cut a deep cañon through an immense conglomerate of porphyritic and quartzose pebbles. The porphyritic pebbles are dioritic and part red and black porphyries.

Some of them are similar to dikes farther up the mountains. Through this great conglomerate bed there are dikes of black porphyry, with pale feldspar. Tufaceous porphyries form a large part of these dikes. The base is purple and the pebbles light green, or the reverse. These conglomeritic porphyries differ from the great beds of sedimentary origin, in having all the pebbles of a uniform character with a crystalline matrix. The sedimentary beds contain pebbles of all sizes and description, in a matrix of small pebbles or coarse sand. Farther up the cañon the great body of the rock is crushed shale and black to gray sandstone; dip vertical, inclining most generally to the east, strike north and south. Two miles up the cañon is a dike of diorite porphyrite, coarse in the middle and fine on the edges. Four miles up is a stratum of gray limestone. More outcrops appear on the north side of the cañon, but whether they belong to the same stratum or different cannot be told, on account of the crushing undergone. These deposits are bunchy, swelling in one case to a width of 100 feet. It is not crystalline. The color is from black to gray. It contains fine specimens of a bivalve shell, and faint traces of corals and univalve shells. These beds are said to extend to the summit, and undoubtedly further examination would reveal more fossils. Several specimens were sent to the National Museum and pronounced Carboniferous in age. We have here, then, the first announcement of the age of the Santa Ana range. This range stands in such intimate relation to the granite and crystalline schists farther south, that an approximate determination of the latter is made possible. Professor Whitney and others following him have classified this range as Cretaceous. Their grounds are utterly untenable stratigraphically, but this discovery of Carboniferous fossils makes the evidence of greater age certain.

On the eastern side of the range, near its northern end, the sandstones were observed to be silicified, being filled with a network of quartz veinlets, exactly similar to the silicification of the metamorphic rocks of the Coast Range proper.

The lowest Cretaceous beds are between Silverado and Williams Cañons, but the fossils are very similar to those generally found through the Cretaceous of this region. The lowest beds are a duplicate of those seen at the mouth of the Silverado Cañon, though apparently a thousand feet lower in the series. Between the two beds there is another conglomerate stratum, carrying bowlders different from any seen in the Santa Ana Mountains. Many of the porphyry bowlders in the basal Cretaceous conglomerates resemble the porphyry about Temescal. The Santa Clara Coal Mine, at the mouth of Silverado Cañon, is undoubtedly in strata of Cretaceous age, though no fossils are found in the strata above till the Miocene is reached. Up the Santiago Cañon as far as Madame Modjeska's place, the fossils are chiefly confined to the eastern side of the cañon, but the character, dip, and strike of the strata on both sides are the same. The Cretaceous is separated from the metamorphics by a line of cross cañons. The highest portions of the Cretaceous terminate in a line of hills with sharp eastern escarpments.

Shrewsbury Cañon comes in just below Modjeska's. After passing the Cretaceous, through which the cañon has cut, the Metamorphic Series was seen to consist of slates and sandstones, followed by light-colored granitic rocks, chiefly hornblende and triclinic feldspar. The metamorphic rocks generally dip to the east.

A mile above Modjeska's the Santiago Cañon cuts through bold cliffs of Cretaceous sandstones and conglomerates, and higher up still has eroded a cañon in the Metamorphic Series. The cliffs, a little back from the stream, rise probably 1,000 feet. Sandstone belonging to the Metamorphic Series outcrops in the cañon for some distance, and is followed by conglomeritic porphyries, containing purple and red bowlders. In some places the inclusions are angular. These rocks are extensively developed about the Santiago Mines and higher up in the mountains.

Just below the Alma Mine, on its western side, the creek has cut through dikes of diorite, which are coarse in the center and fine on the edges. On the hill south of the Alma Mine the diorite is on the opposite or eastern side of the vein. Although the exposures are poor, all the crystalline rocks have the character of intrusives. No blending into the metamorphic rocks has been noticed. About 3 miles up Shrewsbury Cañon several claims are located on the southern continuation of the veins of the Silverado district. Near the head of Santiago Cañon these again appear well defined, and considerable active work was going on here at the time of my visit. The veins here have a direction a little east of south, dipping to the east somewhat less than 45°. It appears that the mineral belt follows a certain line, generally quite regular, without any particular reference to the dikes and bunches of intrusives scattered irregularly here and there. The fissure system has taken a comparatively regular line and the walls may or may not be intrusive. The Alma Mine, the northern claim of the Santiago Silver Mining Company, has been worked by the former operators in a very irregular manner. The veins and stringers as far as exposed lie wholly in the crushed quartzose argillites. A tunnel is now being run to open what is supposed to be the main vein, several hundred feet farther east, and which has syenite on the hanging wall. Other tunnels are being run along the creek, one near a body of granitoid rocks, others in slate or quartzite. The ore is a leafy galena, arranged often in narrow bands with the crystalline orientation different in alternating bands. Sometimes it occurs in the form of large solid bunches. Thus far the ore deposits have been found quite irregular, but it is thought that the main body has not yet been reached. Very little base metal is present. South, on the hill, the Morrow claims have been bonded by the same company and are being opened. On the summit of the hill diorite lies on the eastern side of the veins. Down the southern slope the veins lie wholly in metamorphic rocks; the foot wall being more silicious, the hanging argillaceous. The mineralized portion has a width of 20 feet. A small vein occurs in the upper side, and a heavier one, sometimes reaching 3 feet, on the foot wall. There are occasional stringers in the crushed portions between. The gangue is calcite, with some quartz, all mixed with the broken clayey slates. More zinc-blende and iron pyrites are found here, also a little antimony. In the Alma Mine the richest galena is very fine, and sometimes resembles antimonial ores.

South of these mines, toward Trabuco Cañon, another claim is being worked. South of the Trabuco the conglomerates hide the lode, except at one spot, where it appears and has been worked. The Cretaceous formation grows lower as the Trabuco is approached, and does not appear prominent south of it. In all probability it is covered by the Tertiary, for the elevation and consequent erosion have not been as great in this direction.

Along the road that leads from Madame Modjeska's down to Los Allisos Creek, the sandstones preserve a general southwest dip, at an angle varying from 15° to 30°, and often faulted. Two miles southwest of Modjeska's, fossils of a Tertiary character, probably Miocene, were found in sandstones, which are separated by no physical break, nor any nonconformity from the Cretaceous beds. These sandstones continue down to El Toro, dipping west. The elevation of El Toro is 500 feet.

The ore of mercury lately discovered is found about 2 miles east of Tustin, in an outlying hill of Tertiary sandstone, partly surrounded by the Santa Ana Plain. The hill rises over 100 feet, and is about 1,000 feet long by perhaps half that in width. It is several miles south of the lava deposit near the entrance to Santiago Cañon. The sandstone dips north at a small angle, and consists of a loose aggregate of quartz grains cemented by a kaolinic material. The whole hill has been affected by mineralizing agencies, and can be distinguished a long distance by its red color. Deep red tints and a bright yellow can be seen everywhere. No hardening or metamorphism of the sandstone has taken place. On the north side of the hill is one or more veins of baryta, or heavy spar, running in an east and west direction, and dipping south. They are usually not over a few inches wide. These carry in places the metallic, steel-colored mercury, which on its surface presents a reddish tinge. This mineral is distributed in small masses, usually somewhat vein-like, in the baryta. It is not present in any great quantity. In places the ore appears in minute stringers in the somewhat indurated aluminous sandstones adjoining. A tunnel several hundred feet long has been run into the hill from the south, but it encountered nothing but bright red and yellow sandstones. Another short one on the north met only some little veins of baryta. A short incline has been run down on the veins. Appearances do not indicate that the mineral is present in any quantity. Specimens are in the hands of Professor Dana, but no published analyses have yet been made, so nothing definite can be said about its composition. The deposit must be in some way related to the volcanic action a little distance north.

SUMMARY.

Our knowledge of the geology of this portion of the State has been quite limited and fragmentary up to the present time. Professor Blake, in connection with the Pacific Railroad Survey, crossed San Diego County from east to west, but his notes are confined to the immediate vicinity of the route. Professor Whitney, of the old State Geological Survey, published very little on the geology of San Diego County. W. A. Goodyear, while under Professor Whitney, and later in the employ of the State Mining Bureau, traveled through the county and gave us some additional information. The geologists of Wheeler's survey did not get farther south than Orange County. Professor Whitney, in his report on the general geology of the State, devotes a little space to the region south of Los Angeles, chiefly the Santa Ana and Temescal Mountain regions.

A great diversity of opinion has existed with reference to the age of the granitic and metamorphic rocks. The geologist of Wheeler's survey speaks of the granitic rocks of the Santa Ana range as Azoic. Professor Whitney goes to the opposite extreme, and says that the metamorphic

rocks of the range are Cretaceous or Tertiary. It must be remembered that these are the rocks through which the so-called Azoic rocks have been intruded. Professor Whitney's words, with reference to this region, are: "It is not easy to say, after our hasty examination of this region, what is the age of the metamorphic rocks. They are believed to be partly Cretaceous and partly Tertiary." Professor Whitney's definition of the Coast Ranges is that series of mountains near the coast which has been elevated since the deposition of the Cretaceous. Now, in order to satisfy this definition of the Coast Ranges, he includes the Santa Ana Mountains under that designation, and says that the line between the Cretaceous and the older rocks runs in a southerly direction up the Temescal Valley, and in San Diego County makes a turn to the west, coming out to the ocean near Oceanside. If Professor Whitney had made any examination at all of this section, he would have seen that this line was wholly artificial. It cuts through granite for 10 or 12 miles. This granite is absolutely continuous with that of the higher ranges of San Diego County, and also with that of the Santa Ana range. I had made up my mind, before finding the fossils, that the metamorphic rocks of this range were equivalent to the crystalline schists of the Julian gold belt. This is a belt of schists which runs through the heart of the Peninsula range, from the Mexican line through the Santa Ana Mountains. The schists strike across the summit line at a small angle, and are broken only where granite has been intruded through them. The schists first appear in Jacumba Valley, where they carry a little gold. Extending northwest they appear along the eastern slope of the Laguna range. One portion has been broken off and crowded to the west by the mica diorite forming those mountains. Northward the schists again unite, and in the vicinity of Banner and Julian contain the chief mineral deposits of San Diego County. North of Julian they are less prominent until the western slope of Smith Mountain is reached, where their width is considerable. Between Pala and Temecula Cañon, a body of coarse hornblendic granite has been intruded through them so extensively that their continuity is broken. On the Santa Rosa grant these schists occupy an area several miles in diameter, being less metamorphosed than those farther south. At the northern boundary of the grant, they are again cut off by granite, which has a width of over 7 miles. West of Elsinore the schists appear again, and undoubtedly extend through to Silverado Cañon. Another outburst of granite borders them on the east until Santiago Peak is reached. On the Santa Rosa grant silver occurs in these metamorphic rocks, and increases in amount northward. There are many other small bodies of crystalline schists in San Diego County, but none can be traced so far along such a plainly defined line. This line seems to represent the axis of least metamorphism in the Peninsula range. I believe that there is no question but what the metamorphic rocks of the Santa Ana range are equivalent in age to a large part of those in San Diego County. Although none but Carboniferous fossils have yet been found, it is probable that the Metamorphic Series contains rocks much older as well as younger. I believe that the great convulsion which upheaved and metamorphosed the older rocks, and intruded granite into them, took place as it did in Central and Northern California, between the Cretaceous and the Jurassic. There is no break in the line of granites and crystalline schists the whole length of California.

The mineral deposits of San Diego County are chiefly gold. It is found

in greatest quantity along the line of schists just described, but does not seem genetically related to them any more than to the granite at Deer Park or Mesa Grande. A fissure system is more regular in schistose than in massive rocks, a fact well illustrated in San Diego County. At Julian and Banner the gold-bearing veins are somewhat remarkable in having no relation to intrusive rocks. Small deposits of gold are known to occur at Dulzura and Escondido. The silver veins of the Santa Ana range are peculiar in regard to the great variety of formations in which they occur. From the new camp west of Elsinore, where there are no intrusive dikes near the deposits, north through the Santiago and Silverado districts, there are no two claims with the same kind of ore or wall rocks. The fissure system has been formed along a line of weakness, due, perhaps, to the dikes, but the mineral deposits seem to have no other relation to them.

Dynamic action is far less pronounced in San Diego County than in other portions of California farther north. The crystalline rocks as a whole are fresher and less crushed.

The numerous eruptions of lava in the region explored are of late Tertiary age. At that time a decided uplift, accompanied by faulting, took place, and as a result of this fissures were formed, through which the lava flowed. There are no signs of volcanoes. The lavas are basic, probably largely basalt, but no microscopic examinations have yet been made.

Everything points to a very recent submergence of the Colorado Desert. It is probable that during Quaternary times, the whole mountain range was submerged between 2,000 and 3,000 feet, and that the great beds of unconsolidated gravels and bowlders, which overlie the Tertiary, were then formed. The country rose at the beginning of the Modern period, and the deep cañons have largely been eroded since.

The crystalline rocks of San Diego County are remarkable for their variety and the interesting features which they represent. The crystalline schists represent the oldest formation. In them the granite has been intruded, and in the granite have subsequently appeared the basic rocks, of which the gabbro, on the Cuyamaca, is the most characteristic. Many of the porphyries are younger than the granite, but the extensive body of tuffs and dark porphyries, beginning west of San Marcos and widening toward the south, is of uncertain age. It has undergone greater decomposition than any other crystalline rock, and has every appearance of being one of the oldest.

The time gap between the lowest of the unaltered beds and the crystalline rocks is represented by the greater portion of the Cretaceous. The discovery of sandstones on the borders of the desert, which may prove to be of Lower Cretaceous age, will lessen this gap considerably.

ALAMEDA COUNTY.

By W. L. Watts, Assistant in the Field.

The principal mineralogical details of Alameda County during the years 1891–92 are: The opening of manganese deposits in Mitchel Cañon; the discovery of natural gas at Pleasanton; a further development of the quarries in Niles Cañon; the attention which has been given to rubble rock in the city of Oakland; the development of flowing wells at Alvarado, and the new water supply obtained by the Piedmont Water Co. in the Contra Costa Hills. An important item in the mineralogical economics of all large cities is that of rubble rock, and frequently little regard is paid by corporations to the character of the rubble rock used in macadam and concrete work. The street committee of Oakland has, however, inaugurated a systematic method of testing this important item of city expenditure. It is to be hoped that the example set by the street committee of Oakland will be followed by the street committees of other cities in California.

MANGANESE.

A new manganese mine has been opened by W. P. Bartlett, in Mitchel Cañon, in Sec. 6, T. 4 S., R. 4 E., M. D. M., in the Corral Hollow Mining District. This mine is recorded in the name of J. Taylor & Co., of San Francisco, and H. H. Pitcher, of Livermore. A well-defined ledge has been traced from the Bartlett Mine in a westerly direction to the Ladd Mine, a distance of about 3½ miles. The croppings of the ledge where the new mine is situated are more than 10 feet in width. At a depth of about 5 feet the ledge was only 20 inches in width, but at a depth of 35 feet it widened to 3½ feet, and the percentage of manganese contained in the ore increased to 85 per cent MnO_2, it having previously assayed only 66 per cent. The gangue rock was quartzose. At first the ore was hard and flinty, but at a depth of about 35 feet it passed into soft, bluish ore. The vein is very nearly vertical, with a slight pitch to the south, the strike being east and west. The foot wall is jaspery quartz rock, and the hanging wall is a sandstone. The largest amount of ore has been found in pockets in the sandstone, from some of which more than 40 tons of good ore has been taken. In May, 1892, Mr. Pitcher informed the writer that about 300 tons of ore had been shipped from this mine. The mine is about 16 miles distant from Tracy, upon the S. P. R. R.

A manganese deposit has also been located by O. V. Mendenhall, and he states that samples taken from near the surface show 82 per cent MnO_2.

QUICKSILVER.

The attention of the writer was directed to croppings of low-grade quicksilver ore on the property of O. V. Tuohy, to the north of the State University at Berkeley. These croppings consist of a compact silicious

rock and a silicious conglomerate. They are irregularly distributed along a line having a general northerly and southerly direction, and in a few places they show paints of cinnabar. At the time of the writer's visit no work had been done upon these croppings, and it is doubtful whether they are "in place." An average sample, gathered by hand from these rocks, showed one tenth of one per cent of quicksilver, and a selected sample showed four tenths of one per cent.

A short distance farther up the hill are more extensive croppings of silicious rock, from which, the writer was informed, samples showing a much greater per cent of quicksilver have been obtained. The writer gathered some samples from these upper croppings, but they contained no quicksilver. It is quite possible, however, that further prospecting in the vicinity might have shown ore-bearing rock.

CHROMITE—COAL.

During the two years ending May, 1892, about 600 tons of chromic iron have been shipped from the Mendenhall Mine. It was low-grade ore, assaying only 44 per cent chromic oxide; this was concentrated on a Frue concentrator at Melrose, which raised the grade to 54 per cent.

The price of 50 per cent chrome ores in San Francisco during 1891–92 has ranged from $10 to $12 per ton.

Coal mining has been carried on by J. Treadwell in Corral Hollow.

BUILDING STONE.

The Alta Monte quarry, which was described in the Eighth Annual Report of the California State Mining Bureau, is now owned by A. C. Knowle, who, at the time of the writer's visit to Alameda County, was making preparations to reopen the quarry.

Two new quarries have been opened about 2 miles west of Sunol by Dr. J. F. Newman.

The Farwell quarry, which was also described in the Eighth Annual Report of the California State Mining Bureau, is now operated by a company that was incorporated May 26, 1892, under the name of the Farwell Stone Company. During 1891–92 a large amount of stone was shipped from the Farwell quarry, and Mr. Farwell states that stone from this quarry was tested, and that it withstood a crushing strain of over 6,000 pounds to the square inch. The prices obtained for stone from this quarry, f. o. b. the cars at Farwell's spur track in Niles Cañon, are as follows:

For gray dimension stone	$0 70 per cubic foot.
For blue dimension stone	80 per cubic foot.
For gray rubble stone	1 50 per cubic foot.
For blue rubble stone	2 50 per cubic foot.
For stone over 6 feet in length	10 extra per cu. ft.

RUBBLE ROCK.

The extensive demand for broken rock for macadam and concrete work in Oakland, and in the rapidly developing suburbs of that city, has led to a close inquiry concerning suitable material for street work. The street committee of Oakland adopted a series of tests for rubble rock by a machine, hereinafter described. They also passed an ordi-

nance based upon tests made with this machine, with regard to the rock to be used for street work. Both the machine and the purport of the ordinance are so excellent that they recommend themselves to all cities that have regard for the character of the material used in street work.

The machine used, which is called the "rattler," is similar to a machine used by foundry men for cleaning the rust from small castings. It was built from plans drawn by L. J. Le Conte. "A large iron cylinder, six-sided, and about 6 feet long by 2 feet in diameter, is placed upon its side, with strong supports at both ends about 2 feet above the floor, and it is connected by a belt with the engine which drives it. This cylinder, if the term be proper for a six-sided body, is divided into three compartments by iron partitions. The test is made by pouring into each of these compartments 100 pounds of the rock to be tested and broken to the size used in macadamized paving, and then causing the cylinder to revolve at the rate of twenty-six to thirty revolutions per minute." The machine is built of cast-iron, with small holes punched at intervals, through which the dust sifts and the chips of rock fall as the revolutions of the machine throw the stones together. The capacity of the rock for resisting erosion is thus shown and its toughness demonstrated.

Samples of rock from streets in process of paving were gathered by the City Engineer and the street committee of the city of Oakland. Each sample taken weighed 100 pounds, and was tested in the "rattler" for two hours, with the following results:

Samples Furnished By—	Weighed In.	Loss.
Laundry Farm	100 lbs.	9 lbs.
Alameda Macadamizing Company	100 lbs.	26 lbs.
Oakland Paving Company	100 lbs.	16.5 lbs.
Oakland Contracting Company	100 lbs.	19 lbs.
Vandercook	100 lbs.	15 lbs.

A second run on the same samples for three hours each showed:

Sample Furnished By—	Weighed In.	Loss.
Laundry Farm	90.5 lbs.	2.76 lbs.
Alameda Macadamizing Company	72 lbs.	8.33 lbs.
Oakland Paving Company	83.5 lbs.	5.37 lbs.
Oakland Contracting Company	81 lbs.	3.08 lbs.
Vandercook	85 lbs.	4.70 lbs.

The total loss by this experiment showed:

Sample Furnished By—	Weighed In.	Loss.
Laundry Farm	100 lbs.	11.76 lbs.
Vandercook	100 lbs.	19.70 lbs.
Oakland Paving Company	100 lbs.	21.87 lbs.
Oakland Contracting Company	100 lbs.	22.08 lbs.
Alameda Macadamizing Company	100 lbs.	34.33 lbs.

The gentlemen who conducted this experiment state that, as might naturally be expected, the first loss was the greatest from the mos'

angular rocks, which suffered the most severely from cleavage, and that the subsequent loss was from erosion.

It is obvious that the above described method of testing rubble rock is most excellent, yet there are a few points, with regard to the way of carrying out the experiment, that ought to be attended to in order to obtain accurate results: First, the quality of the stone in many quarries is variable, therefore the experiments should be repeated from time to time; secondly, care should be taken that the sample represents the average output of the quarry at the time of sampling, for the sampling is quite as important as the testing, and where a large amount of rock is required for expensive public works it demands the same care and the same methods of sampling as does valuable ore. A wagonload should be taken either automatically from the crusher or in definite proportion from the various loads of crushed rock delivered. The sample load should be "dumped" in a pile and "quartered down," as the ore is sampled in an ore yard. When a standard size for the fragments of rock has been established by law or by contract, the sample should be carefully sized, and all fragments that did not come within certain limits of the standard size should be weighed and added to the loss the sample was found to sustain in the "rattler." Even when no standard of size has been insisted on, and it is simply desired to estimate the capacity of the rock for resisting wear and tear, the final sample, consisting of a few hundred-weight of fragments of rocks, should be sized, so that the fragments will be of a uniform size. If this is not done, the increased surface and the greater number of sharp edges and points in samples consisting of smaller sized fragments of rock, will place such samples at a disadvantage.

Having dwelt somewhat largely upon the method of testing rubble rock employed in Oakland, and having stated at length the result of practical tests on certain samples of rubble rock used in that city, it will not be without interest to describe the quarries which furnished the samples of rock, and to pay some regard to the lithological character of samples obtained therefrom.

The Laundry Farm Quarry.—This quarry was opened in July, 1890, at the summit of a hill belonging to the Contra Costa range, distant about three quarters of a mile in a northeasterly direction from the terminus of the California Railroad at Laundry Farm, and about 8 miles northeast of Oakland. The rock is quarried from the summit, and also about 100 feet farther down the hill. It is conveyed by a gravity tramway to two No. 4 Gates crushers, which are situated at a lower elevation. These crushers each have a capacity of 250 cubic yards every ten hours. Since the quarry was opened, about 90,000 yards of the rock have been used. The official tests have proved it to be of good quality and suitable for macadam and concrete work. The California Improvement Company is prepared to supply this crushed rock, f. o. b. the cars at Fruitvale, for $1 25 per cubic yard, and it has been delivered in San Francisco for $2 per cubic yard. A sample of the rock was obtained by the writer from the quarry. Macroscopic examination showed it to be a rock of compact texture and irregular fracture, showing in places a small amount of infiltrated calcareous matter, and varying in color from grayish to blackish. A microscopic slide of this rock was prepared by Mr. C. Schneider, Determinative Mineralogist to the California State Mining Bureau. Under the microscope, the specimen

showed crystals of feldspar, and the magma was somewhat colored by chloritic matter. The alteration to which the rock was subjected prevented classification by microscopic methods, but its appearance, both under the microscope and in the field, leads to the conclusion that it is an altered intruded crystalline rock.

The Vandercook Quarries.—These quarries are situated in the first tier of hills to the northeast of Brooklyn railroad station, from which they are distant about 3 miles; their height above the Brooklyn station is between 300 and 400 feet, and the road thereto is down grade all the way. They are owned by H. Heyland, who lives near them, and they are leased to Messrs. Vandercook, of Oakland. The rock is a metamorphic sandstone of variable texture. No work was being done in these quarries when the writer visited them, but in one quarry a breast of about 100 feet in height was exposed. This stone is used extensively for macadam and concrete work. At the time of this writing the plant used for crushing the rock is situated about 1½ miles from the quarry, between the quarry and Brooklyn station. The plant consists of a Wheeler crusher, capable of crushing from 40 to 60 yards of rock every ten hours. The crusher is run by a twenty horse-power engine.

The Alameda Macadamizing Company.—This company was organized in Oakland in 1874, and their quarry is situated at Piedmont, about a mile from the head of Lake Merritt. The stone obtained from this quarry is a close-grained metamorphic sandstone, and is in great demand for macadam and concrete work; it is also used for rip-rap work on the tidal canal at Oakland. At the time of the writer's visit to the quary the daily output was about 250 yards of crushed rock. In the quarry a breast of about 100 feet in height has been opened. A Burleigh drill is used, and drill-holes about 20 feet deep are made. The bottoms of the drill holes are "sprung" with giant powder and then charged with three kegs of black powder. The Superintendent of the quarry states that by avoiding seams he considers such a charge should bring down about 3,000 tons from the face of the quarry. The rock is drawn by a steam hoist up a short incline from the quarry to two No. 3 Blake crushers. Each of these crushers has a capacity of about 175 yards of rock a day. The crushed rock passes into a revolving screen, which regulates the size as required. The screenings, after the dust is sifted from them, are used for the top dressing in fine concrete work.

The Oakland Paving Company.—This company was organized in Oakland, in 1869. Their quarry is situated on Broadway, about 2½ miles from the Oakland City Hall. The stone is a metamorphic sandstone, which in places shows calcareous infiltrations. It is extensively employed in macadam and concrete work, and the writer is informed that it is used in the foundations of the towers at the end of the Oakland mole. An immense amount of stone has been taken from this quarry, and the rock seems to be of a very uniform quality. Drill-holes about 18 feet deep are made with a Burleigh drill; giant powder is preferred by quarry men. The rock is drawn by a steam hoist to a Gates and a Blake crusher, which together daily crush about 250 yards of rock. The rock is screened through a revolving screen, the slots of which are 3 inches in diameter, and the screenings pass through another revolving screen, having a 3-inch mesh, which sifts the finer particles from them. The crushers are run by a seventy-five horse-power engine.

The Oakland Contracting Company.—This company obtain their rubble rock from the basalt quarries near Cordelia, in Solano County. A description of these quarries is given in the Tenth Annual Report of the California State Mining Bureau. The rock is a doloritic lava, and no doubt the hardest of any of the samples subjected to the test previously mentioned. It would naturally be expected that its loss in the "rattler" would be rather from cleavage than abrasion. And this was borne out by experiment, for its loss after the first portion of the test, which was a run of two hours in the "rattler," entitled it to only fourth place amongst the five samples tested. During the second portion of this test, which was a run of three hours' duration, on the same samples, its loss was so slight that it was entitled to second place for that run; although its previous loss in the first run had so diminished the sample that the final result was not affected by the behavior of the rock during the second run. It is in the case of such rocks as these that sizing the broken rock forming the sample, before testing it in the "rattler," would produce the most marked results.

Quarry at Sheep Island.—In 1890, C. T. H. Palmer and Mr. Eastman, of Oakland, leased this quarry from the Southern Pacific Improvement Company. Messrs. Palmer and Eastman supplied crushed rock to parties in Berkeley and Stockton. The plant was destroyed by fire in May, 1892. It is the opinion of Messrs. Palmer and Eastman that crushed rock can be delivered in San Francisco from this quarry at $1 50 per per cubic yard.

MELROSE SMELTING WORKS.

These works belong to Whittier, Fuller & Co., and are operated principally for the purpose of obtaining lead for the manufacture of white lead. The precious metals are extracted by cupellation. During 1891–92, the furnaces at these works were operated for a few months. The ores reduced were obtained from California, Utah, and Idaho. The California ores came principally from Inyo County.

Whittier, Fuller & Co. state that the output of their smelting works for the year 1891 and first half of year 1892 was as follows: Lead, 663,868 pounds; gold, 119 ounces; silver, 46,714 ounces. The gross weight of ore treated was 1,362,700 pounds.

REMILLARD BRICK YARD.

This brick yard was established about ten years ago in the Livermore Valley. The plant consists of two Hoffman kilns, which together have a capacity of 17,000,000 bricks a year. Both common and stock brick are made in this yard, and are all machine made. During 1891–92 the price of brick, f. o. b. at Livermore, averaged $7 for common brick and $14 for stock brick. About 130 men are engaged during the season at these yards; only white men are employed.

WELLS YIELDING BRACKISH WATER.

About 3 miles south of Pleasanton many of the wells yield brackish water, the formation being:

Soil	4 feet.
Blue clay	18 feet.
Cement gravel, yielding brackish water	1 foot.

FLOWING WELLS.

In 1890 a 7-inch well was bored on the Silva ranch, about a mile southwest from Pleasanton, and the following formation was observed:

Clay loam	2 feet.
Quicksand	2 feet.
Blue clay, passing into yellow	43 feet.
Gravel, yielding flowing water.	

At this depth a stream of water flowed 14 inches above the casing, the top of which was 2 feet above the surface of the ground. When 14 feet of casing was added, making in all 16 feet above the surface of the ground, the water flowed 4 inches above the top of the casing.

In 1889 a flowing well was obtained on the ranch of J. W. Kottinger, about half a mile east from Pleasanton. This well is 7 inches in diameter and was bored to a depth of 71 feet. At this depth the water flowed 4 feet above the casing, the top of which was 3 feet above the surface of the ground.

On the Harms ranch, about half a mile west of the Valensin ranch, which is at a somewhat greater altitude, a boring showed:

Sandy loam	2 feet.
Dry sand	6 feet.
Blue and red clay	40 feet.
Gravel	12 feet.

From this gravel the water flowed 1½ inches above a 7-inch casing, the top of which was 2 feet above the surface of the ground.

A flowing well was also obtained about 200 yards distant from the Harms well.

Other borings in this vicinity, which have been made at a somewhat greater altitude, although penetrating a similar formation, have failed to yield flowing water.

WELLS WHICH DO NOT FLOW.

At Pleasanton school house, in the southwestern edge of the town, a well showed the following formation:

Soil, fragments of rock, and hardpan	27 feet.
Blue clay	90 feet.
Gravel, with water	3 feet.
Blue clay, sand, and gravel	80 feet.

On the Lyster property, in Pleasanton, a well showed:

Soil	6 feet.
Quicksand, with brackish water	2 feet.
Grayish clayey sediment	28 feet.
Coarse sand, with water	2 feet.

On the proporty of L. Carr, in the eastern portion of Pleasanton, a boring penetrated:

Clay loam	2 feet.
Blue clay and hard angular fragments of broken rock	25 feet.
Gravel, with a small amount of water	3 feet.
Blue clay	36 feet.

It is said that "some gas" was observed in this well, and that when it was first bored a rushing noise was heard, which lasted about ten minutes.

A well was bored in the eastern outskirts of Pleasanton, on a knoll about 20 feet above the town. The auger penetrated:

Red gravelly clay	2 feet.
Red clay	4 feet.
Cobblestones closely packed	5 feet.
Red clay	27 feet.
Blue clay	44 feet.
Gravel	3 feet.

Water, which rose to within 38 feet of the surface.

On the Donahue ranch, in the western portion of Pleasanton, a well showed:

Loam	7 feet.
Grayish clay	8 feet.
Quicksand	2 feet.
White water-worn gravel, which contained plenty of water	10 feet.

On the Salisbury ranch, about half a mile west of Pleasanton, the formation is:

Surface soil, grayish loam	7 feet.
Quicksand	4 feet.
Gray clay	13 feet.
White, clean washed gravel, with much water	17 feet.
Blue clay	24 feet.
Hardpan	2 feet.
Blackish gravel, containing a small amount of water	38 feet.
Blue clay	41 feet.
Gravel, with water	10 feet.
Blue clay	24 feet.
Quicksand	5 feet.
Hardpan	½ foot.
Gravel, with water	7 feet.
Blue clay with some pieces of rock	2 feet.
Gravel and water-worn cobblestones	12 feet.
Blue clay and broken rock	5 feet.
Broken rock and gravel	3 feet.

At this depth hard rock, supposed to be bedrock, was struck. Upon the completion of this well the water stood at a depth of 5 or 6 feet from the surface. Nearly all the water was obtained from a depth of about 41 feet.

On the Sutherland ranch, about 2 miles north of Pleasanton, a well was sunk through:

Sandy loam	1 foot.
Sand	6 feet.
Quicksand	4 feet.
Blue clay	37 feet.
Gravel, with water, which rose to within 6 inches of the surface	25 feet.
Grayish clay and sand	30 feet.

On the Valensin stock farm a well showed:

Sandy loam	5 feet.
Quicksand, with water	4 feet.
Blue clay, passing into red clay	37 feet.
Gravel	4 feet.

This gravel yielded an abundant supply of water, which stood at a depth of about 4 feet from the surface.

Around Livermore the surface water is usually struck at a depth of about 70 feet in gravel, which is frequently interstratified with thin strata of clay. When the creek which flows to the south of Livermore

is full, the water plane to the north of the creek rises to about the same height as the water in the creek. On the south side of this creek the formation is principally cement gravel, which has been penetrated to a depth of 120 feet. Seepage water is struck at a depth of 40 feet, but the supply is scanty.

Half a mile south of Livermore, on the Rasmussen ranch, a well showed:

Gravelly soil	2 feet.
Gray clay and pebbles	48 feet.
Gravel, with water	3 feet.

Eastward from Livermore a supply of water is obtained in gravel at a depth of 75 or 80 feet. The depth of the wells becomes greater as the hills are approached. Northward from Livermore the wells are shallower, especially in the northwestern portion of the valley.

WATER COMPANIES UPON THE EASTERN SIDE OF SAN FRANCISCO BAY.

The Contra Costa Company.—The principal supply of Oakland is furnished by the Contra Costa Water Company. Application was made by the writer to the officers of this company for particulars concerning their water supply, but at the date of this writing no information had been given.

The Piedmont Water Company.—This company was organized in December, 1891, and incorporated in Oakland under the name of the Piedmont Spring Valley and Power Company. The tunnels from which this company derive their supply of water are about 5 miles distant from Oakland, and are situated in the Contra Costa Hills. These tunnels were commenced in 1891, and in May, 1892, ten tunnels had been completed, varying in length from 250 to 440 feet. They are situated between the altitudes of 1,000 and 1,400 feet. The officers of this company state that the total amount of water furnished by these tunnels has been estimated at nearly 2,000,000 gallons in twenty-four hours. The water flows from the tunnels into receiving reservoirs. One of these, which has a capacity of 10,000,000 gallons, is located about 3½ miles north of Oakland, at an altitude of about 900 feet. Another reservoir, of about 5,000,000 gallons capacity, is situated at the Linda Vista Terrace, at an altitude of about 190 feet. In June, 1892, the writer was informed that about 10 miles of pipe had been laid. The water is sold at both household and meter rates, at the option of the consumer. The rates are established by the City Council. The meter rate for 1892 was fixed at 40 cents a thousand gallons.

The Alameda Water Company.—The town of Berkeley is supplied with water by the Alameda Water Company, which was incorporated in 1884. This company obtains water from wells and tunnels in the Contra Costa Hills, and they pipe it a distance of 2 or 3 miles to the town. There are altogether six tunnels belonging to this company, and they vary in length from 300 to 2,000 feet, and supply from 250,000 to 300,000 gallons of water every twenty-four hours. Three of these tunnels are situated near Wildcat Creek, and penetrate the hills dividing that stream from the San Pablo Creek. Another is in Telegraph Cañon, and two more are situated in the western slope of the Contra Costa Hills, directly eastward from Berkeley. The tunnels near Wildcat Creek yield the most

water. The wells belonging to this company are described under the head of "Subterranean Water Supply." They are situated at the head of Wildcat Creek, and yield about 40,000 gallons of water every twenty-four hours. The company supplies Berkeley with about 500,000 gallons of water daily during the summer, and with about 300,000 gallons of water daily during the winter. Water is sold by both household and meter rates. The meter rates are as follows: For any amount less than 2,000 cubic feet, 55 cents a thousand gallons; for any amount over 2,000 and less than 3,200 cubic feet, 50 cents a thousand gallons; for any amount above 4,000 cubic feet, the rate does not exceed 35 cents a thousand gallons. Water is furnished the town for public works at the rate of 25 cents a thousand gallons.

The town of Alameda is furnished with water by the Artesian Water Company, who obtain their supply from artesian wells at Fitchburg, as mentioned under the head of "Subterranean Water Supply," and from seven wells, which are situated at High Street, in the eastern end of the town. The wells at High Street vary in depth from 120 to 450 feet, and in diameter from 10 to 16 inches. They yield about 40,000 gallons of water an hour, and continued pumping lowers the water to a depth of about 20 feet. The water is distributed by a modification of the Holly system. The Artesian Water Company furnishes Alameda with about 80,000 gallons of water an hour during the summer, and with about 25,000 gallons an hour during the winter.

SUBTERRANEAN WATER SUPPLY ON THE EASTERN SIDE OF SAN FRANCISCO BAY.

Along the Oakland waterfront, and extending inland for a distance of probably 1½ miles, the superficial formation is principally sand, which in some places is traversed by thin strata of clay. In this sand water is obtained at a depth of from 40 to 100 feet, and people who have any regard for health, use a surface pipe outside the casing of such shallow wells. This pipe extends from the surface down to the first stratum of clay, and the space between the two pipes is filled with cement, the object, of course, being to shut off deleterious infiltrations. The writer is informed that the wells furnishing water to many of the cheaper class of residences in the above mentioned portion of Oakland do not exceed a depth of 60 feet, and that in many cases the precaution of using a surface pipe is neglected. The wells which terminate in the sandy formation usually furnish sufficient water for a windmill pump capable of drawing about 600 gallons an hour. In such wells the water usually stands at a depth of from 10 to 12 feet, but deep well pumps are used, for continued pumping soon lowers the water to a depth of 35 or 40 feet. Along the waterfront the formation is principally as follows:

Sand	60 to 100 feet.
Blue clay	20 to 40 feet.
This blue clay is traversed by numerous thin strata of bluish sand with muddy water, and shells, principally *Macoma nasuta* and *Ostrea lurida*.	
Yellow clay and cement	120 to 140 feet.
Three or four strata of water-bearing gravel, separated by hard yellow clay or cement, altogether about	30 feet.
Yellow clay	60 to 100 feet.
In this clay another stratum of water-bearing gravel is usually struck at a depth of about 360 feet.	
Blue clay	30 to 100 feet.
Hard yellow clay and cement	200 to 270 feet.
Water-bearing gravel	8 to 12 feet.

In the marsh a surface pipe, 2 or 3 inches larger in diameter than the well pipe, is sunk to the first solid bed of clay, which is usually struck at a depth of from 80 to 120 feet. When the well is finished, the space between the two pipes is filled with cement to shut off the salt water. After cementing the well, the water generally rises to within from 4 to 12 feet of the surface.

The best water-bearing strata along the waterfront are found at a depth of from 280 to 360 feet, and wells of this depth, which are 7 or 8 inches in diameter, will furnish sufficient water for pumps drawing from 3,000 to 5,000 gallons an hour; indeed, some of the best wells yield from 8,000 to 10,000 gallons an hour. Occasionally strata are penetrated from which the water rises to the surface, and even flows over the casing. In some instances, on these marshy lands, wells have been obtained which flow when it is high tide in the bay, but when the tide is low, the water in the wells sinks several feet below the top of the casing. It is said that about twenty-seven years ago a well was bored to the depth of about 500 feet, near the workshops of the S. P. R. R., and that a strong flow of water was obtained.

The cost of boring wells in Oakland and Alameda is $1 a foot for the first 50 feet, below which depth 25 cents a foot additional is charged at each 50 feet of increased depth. This price includes casing and surface pipe through the sandy formations.

A comparison of observations made by those who have bored wells along the waterfront, shows that this description holds good in a general way from Sixteenth Street to a point near the old Neptune Gardens, in Alameda.

Farther inland, near the eastern and northeastern margin of the sandy formation, the sand is of less depth; the stratum of blue clay seldom exceeds 20 feet in thickness; indeed, it is sometimes absent, and strata of water-bearing gravel are usually found at a depth of from 70 to 120 feet. Below this depth the formation is similar to that along the waterfront, but in some instances wells have been bored to a depth of several hundred feet without a large supply of water being obtained.

Farther toward the foothills the sandy formation ceases. The yellow clay comes to the surface, and the formation is principally yellow clay, angular fragments of rock, and cement gravel. In such localities the occurrence of water-bearing strata is more uncertain, but a supply of water for domestic use is usually obtained either in the first stratum of water-bearing gravel, at a depth of from 60 to 100 feet, or from the second stratum at a depth of about 200 feet.

From what the writer could gather with regard to wells that have been bored toward the foothills, in the direction of Piedmont, the following appears to be the general character of the formation:

Yellow clay	30 to 40 feet.
Dry gravel and coarse sand	10 to 15 feet.
Yellow clay	10 to 20 feet.
Gravel, with water	8 to 10 feet.
Yellow clay and fragments of rock	100 to 150 feet.

Beneath the yellow clay is sand and gravel with water, which rises to within about 28 feet of the top of the casing.

In the vicinity of Temescal bored wells are usually from 140 to 150 feet deep, the formation being principally clay and cemented gravel. Throughout the southern part of Temescal, especially, a good supply of water can be obtained at these depths. The water usually stands at a

depth of from 25 to 30 feet. In this vicinity irregular strata of gravel are also frequently met with, which afford a fair supply of water at a less depth.

South of Berkeley, in the vicinity of Klinknerville, on the O'Neil tract, a 12-inch and a 7-inch well were bored. These showed a black soil for about 3 feet and a cemented gravel for 130 feet, which yielded some seepage water. Water-bearing sand and gravel were then penetrated for about 14 feet, which yielded a good supply of water. The water from these wells flows from the top of the casing when the windmill pumps are not working.

In other places in Klinknerville borings were made to a depth of about 160 feet. These wells did not flow, but in them the water stood at the depth of about 10 feet. In this vicinity a supply of water for domestic use can generally be relied on at a depth of something less than 100 feet; and a second water-bearing stratum is generally struck at a depth of from 160 to 175 feet. Some well-borers are of the opinion that a bed of gravel containing a large amount of water extends from the vicinity of the Deaf and Dumb Asylum in a southwesterly direction toward the bay. In a well at Butchertown, near the bay, flowing water was obtained at a depth of about 175 feet; the formation is principally clay and cement gravel. Within a short distance of this well borings were made to a depth of 300 feet, and only seepage water was obtained. It is said that there are other flowing wells near the bay in this neighborhood.

In West Berkeley the formation is principally clay, gravel, and cement; and bored wells for house use are usually from 60 to 80 feet in depth. The water stands at a depth of from 20 to 25 feet. A well was bored at the planing mill, close to the bay, and clay and cemented gravel were passed through for 390 feet, at which depth sandstone is said to have been struck. This well yielded only a small supply of water.

Both in West and East Berkeley there are many dug wells from 20 to 30 feet deep, which yield a supply of water for domestic use. The writer was informed that continued pumping from shallow dug wells near the bay had introduced salt water. In East Berkeley the formation penetrated by wells is principally yellow clay, with angular fragments of rock and cemented gravel. This drift formation varies in depth from about 15 and 20 feet near the hills, and more than 100 feet in the vicinity of Dwight Way and Shattuck Avenue. In some places in the hills, however, the drift formation has been penetrated for about 64 feet. In East Berkeley the bored wells for house use vary in depth from 30 to 90 feet.

The cost of bored wells in East Berkeley is $1 a foot, including the casing, for the first 100 feet. Dug wells cost $2 50 a foot for the first 30 feet. A contract is generally made to work by the day if rock is struck.

The writer learned that the University of California had made efforts to procure a water supply from wells and tunnels in the University grounds. He therefore placed himself in communication with the Secretary of that institution, who kindly furnished him with the interesting particulars set forth in the following letter:

UNIVERSITY OF CALIFORNIA,
BERKELEY, October 27, 1892.

W. L. WATTS, *Field Assistant, State Mining Bureau, San Francisco:*

DEAR SIR: * * * It has been and is the desire of the Board of Regents to ascertain with certainty that there are or are not available water sources on the University site, before seeking a supply from sources beyond control of the University. To this end investigation has been approximately thorough and prudently expensive. We have not yet finally solved the problem. The excavation of a tunnel on the hillside lying east of the University forest was begun in 1883 and continued off and on until about February, 1886, at which time it measured 1,400 feet in length. The cost was about $4,500. The excavated material has been worth to the University about $2,500, and the water received and used was about $1,000, making the cost of the tunnel in excess of returns about $1,000.

The tunnel pierces blue sandstone throughout its entire length, with the exception of a few narrow walls of yellow sandstone, and about 30 feet of drift at the entrance. A few very thin seams of coal were found, enough to make a test, which was done by Professor Christy, who reported that this coal produced 60 per cent of fine coke. The water product of this tunnel has averaged about 3,000 gallons per day, counting the winter and the summer supply.

Seventy-three wells were drilled in 1890, varying in depth from 10 to 73 feet. These wells were sunk mostly on the north side of the University site, and are scattered from the high hill east of the forest to the west end of the grounds. They pierced adobe and the varied drift, loam, brown, red, and yellow clay, sand, gravel, bowlders, hard yellow and blue sandstone, and rotten reddish rock. Of these only one well (and that at the east line of the forest) seemed to be promising, and at that point a short tunnel was excavated through a deposit of broken rock of varied character. For a few days water seemed to be abundant, but was soon exhausted. It is thought this pocket of broken rock may prove to be a useful, though small subterranean reservoir, to be filled by winter rains.

Another tunnel was run into the side of the hill east of the forest and well up on its flank. It was short and non-productive.

During the summer of the present year a 6-inch well was drilled in the bed of Strawberry Creek, within 40 feet of the eastern boundary line of the University site. This well is 120 feet deep and the formation pierced consists of blue sandstone and dark shaly material, so intimately associated and intermixed that no separation of these two prevalent kinds of rocks into definite strata is possible. The whole of the rock passed through must be regarded as one formation of sandstone and shale of varying character. A pump has been placed at this well, which lifts into the old reservoir about 1,000 gallons of water per day.

A second well, with a diameter of 10 inches, is being drilled about 30 feet farther up the cañon, and it is expected that this well will be sunk to a depth of about 500 feet.

The Regents have worked over the ground at their command very thoroughly, and while the result has not been great, the expense has been comparatively small, as $3,000 actual outlay, above the value of returns, will be the limit of expenditure up to this time.

Two things are to be noted in this search for water on the University site, which lies on the western slope of the Contra Costa Hills, below Grizzly Peak:

First, the bedrock is sandstone, impregnated with blue clay—a combination that is impervious to water. Hence, the winter rainfall, when it permeates the drift on the hillsides and reaches the blue sandstone bedrock, simply runs off under the drift down to the marshes or into the bay. The rainfall has no place to lodge, except in gravel pits, small depressions, and crevices in the bedrock.

Secondly, when a well is sunk into this blue sandstone bedrock and finds crevice water, it is soon drained, and the well becomes useless, unless, indeed, the well happens to strike a system of crevices of great extent. I have no knowledge, however, of any well in this vicinity on the western slope of the Contra Costa Hills so happily placed.

There is found, however, near the top of the ridge of these high hills (Grizzly Peak is 1,759.52 feet above the sea), a water-bearing rock, but it is outside of our jurisdiction. It is yet to be seen what may be found on the hillsides at a depth of 500 or 1,000 feet; the presumption, however, is that but little water will be obtained, unless a system of crevices be found.

It is probable that more water will be found by tunneling into the edge of the ridge, or by sinking very deep wells on the level part of the campus, where the surface is only 234 feet above mean tide.

Very respectfully,

J. H. C. BONTÉ,
Secretary University of California.

Several wells were bored for the Alameda Water Company at the head of Wildcat Creek. The formation penetrated is clay and broken rock, to a depth of from 30 to 70 feet. Beneath this, in some wells, a very hard bedrock was struck, but in others the bedrock was sandstone. Some of these wells yielded an abundant supply of water, and in several

instances a large stream of flowing water was obtained. In a few of the wells no water was found.

Throughout the greater part of East Oakland, the formation is usually yellow clay and cement to a depth of from 60 to 80 feet, at which depth a fair supply of water was obtained in sand or gravel, somewhat mixed with clay. A second stratum of water-bearing gravel is usually struck at a depth of from 150 to 200 feet, the intervening formation being principally yellow and blue clay. The water stands at a depth of from 12 to 20 feet. Wells for household use generally tap only the first water-bearing stratum.

Near the foothills, however, the water supply is more uncertain, and there are instances of wells which penetrate to a depth of several hundred feet without obtaining a good supply. At Twenty-third Avenue and Fruitvale, and thence along the San Leandro road, the surface soil is chiefly adobe to a depth of from 4 to 6 feet, beneath which the formation is yellow clay and cement to a depth of from 75 to 100 feet. The best water-bearing stratum is generally struck at this depth, and in many localities a small stratum of water-bearing gravel is found at a depth of from 30 to 50 feet.

At the Power House, which is about 3 miles from East Oakland, on the San Leandro road, the following formations are penetrated:

Black adobe soil	3 feet.
Yellow clay	15 feet.
Thin stratum of sand and gravel, with surface water.	
Yellow clay	10 feet.
More water.	
Blue clay	25 feet.
Thin stratum of sand and gravel, with water.	
Dark-colored clay	40 feet.
Gravel, with water	4 feet.
Yellow clay	74 feet.
Gravel, with water	3 feet.

This was a 10-inch well, and at its completion the water stood at a depth of 7 feet 9 inches. At the back of the Power House, between the San Leandro road and the foothills, there is a tract of land from half a mile to a mile wide, in which it is said a good supply of water for domestic use can be obtained at a depth of from 40 to 60 feet.

At Fitchburg, near Seminary Park Station, the Artesia Waterworks of Alameda have twenty-one wells, varying in depth from 70 to 500 feet, and varying from 7 to 12 inches in diameter. All the wells are pumped by one suction pump, which has a capacity of 100,000 gallons an hour. The wells yield on an average about 60,000 to 70,000 gallons an hour. The formation penetrated by the wells consists of yellow clay and cement, with strata of water-bearing gravel. The depth of the wells is so regulated that few of them tap the same water-bearing stratum. The largest amount of water was obtained between the following depths: 70 to 80 feet, 150 to 175 feet, 240 to 260 feet.

Alameda appears to be situated on a sand bank about 4 miles long and 1 mile wide. It is joined to the mainland at Fruitvale and Melrose by an isthmus, through which the tidal canal is now being cut. At the eastern end of the town, the superficial stratum of sand is about 40 feet in thickness. This sandy stratum increases in thickness toward the western end of the town, where it has been penetrated for more than 100 feet. This sandy formation is composed of yellow and gray sand, the coarser portions of which frequently contain water; toward the bottom

of the sandy stratum, the sand becomes bluish and mixed with clay. Beneath the sand is a stratum of blue clay from 10 to 20 feet in thickness, and beneath that a yellow clay, which contains a stratum of water-bearing gravel. An abundant supply of good water is usually obtained from this gravel at a depth of from 80 to 90 feet, in the vicinity of High Street, and along the northern side of Alameda as far west as Willow Street, near the head of Oakland Harbor; beneath this gravel is more yellow clay, with an occasional stratum of blue clay to a depth of about 140 feet, when another good stratum of water-bearing gravel is struck.

In this portion of Alameda, flowing wells were formerly obtained by tapping these strata of water-bearing gravel, but within the last seven or eight years so many wells have been bored, and so much water is pumped from them, that the water now stands at a depth of from 6 to 8 feet at all seasons of the year. For 1½ to 2 miles west of Park Street, the finest water-bearing gravel is struck at depths varying from 120 to 160 feet, and an abundant supply of good water is obtained at that depth. These wells are usually pumped with a windmill pump, capable of raising from 600 to 1,000 gallons of water an hour. A 7-inch or 8-inch well, penetrating this gravel, will yield from 3,000 to 4,000 gallons an hour with a deep well pump; and some wells will yield from 6,000 to 8,000 gallons an hour.

Throughout the central portions of the town of Alameda, the second stratum of water-bearing gravel occurs at a depth of from 220 to 240 feet, and the water stands in the wells at a depth of from 8 to 12 feet. In the west end of Alameda, the formation is similar to that already described, but the wells are deeper and the strata of both sand and clay are thicker.

Westward from Webster Street the first water-bearing gravel is struck at a depth of from 230 to 280 feet, at which depth a good supply of water is obtained. Wells are seldom bored deeper than this stratum in the western portion of Alameda. The water stands at a depth of from 8 to 12 feet.

A 7-inch well, which was bored to a depth of 280 feet at the round house of the Narrow Gauge Railroad, was tested, and found to yield 9,000 gallons an hour; and continued pumping, at this rate, failed to lower the water to a greater depth than 24 feet.

A well was bored at the end of the Alameda mole in 1892, and the following record was obtained by the writer from the well-borers:

Water	22 feet.
Mud	18 feet.
Black sand	40 feet.
Yellow sand	44 feet.
Gray sand	72 feet.
Blue sand	82 feet.
Clay	90 feet.
Brown "vegetable mold"	94 feet.
Hard blue clay	96 feet.
Blue clay	110 feet.
Sand and clay	113 feet.
Blue clay	120 feet.
Blue sand	130 feet.
Blue clay	136 feet.
Brown clay	182 feet.
Blue clay	186 feet.
Blue sand and clay	200 feet.
Blue clay	207 feet.
Black clay	212 feet.
Blue clay	216 feet.
Hard sandy clay with pieces of wood	220 feet.

Hard sand and clay	226 feet.
Gravel and clay	230 feet.
Blue clay	232 feet.
Quicksand	250 feet.
Quicksand with one foot of blue clay	259 feet.
Quicksand	260 feet.
Gravel mixed with quicksand	290 feet.
Very hard clay	300 feet.
Sand and clay	331 feet.
Quicksand	358 feet.
Packed sand, quicksand, and gravel	362 feet.
Blue cement	373 feet.
Yellow cement	378 feet.
Yellow and red cement	383 feet.
White "chalk rock"	402 feet.
Sand "rock"	404 feet.
Yellow cement clay	408 feet.
Soft sandy "rock"	409 feet.

At this depth the water stood within 8 feet of the top of the casing.

In the blue clay beneath the superficial sandy formation at Alameda thin strata of broken oyster shells are frequently passed through, pieces of wood and decayed vegetable matter are encountered, and in some instances pieces of bone have been brought up by the sand pump.

In a well on Webster Street a log of wood was bored through at a depth of 173 feet.

The writer is informed that throughout Alameda many of the cheaper class of residences obtain their water supply from dug wells, which penetrate the sand to a depth of from 16 to 24 feet. Between Oakland and Mount Eden, the surface water stands at a depth of from 8 to 10 feet, and a good supply is found at a depth of from 40 to 100 feet. Near the bay several small flows of water have been obtained at a depth of something less than 200 feet, while in other wells in that vicinity the water stands within a few feet of the surface; along the line of the S. P. R. R. it stands at a depth of from 30 to 40 feet. At San Leandro the formation is as follows:

Black soil	3 to 4 feet.
Yellow clay	18 to 25 feet.
Gravel, with good water	7 to 25 feet.
Yellow clay	20 to 30 feet.
Gravel, with water	3 to 4 feet.
Yellow or blue clay	30 to 40 feet.

In this neighborhood a good supply of water can be obtained in dug wells at a depth of from 30 to 35 feet.

At San Lorenzo the following formation has been observed:

Surface soil	4 to 5 feet.
Yellow clay	15 feet.
Coarse sand	2 feet.
Blue clay	50 feet.
Coarse sand, with water	3 feet.

At Haywards, and thence toward the foothills, nearly all the wells are dug, and a fair supply of water is obtained at a depth of from 20 to 40 feet. During the dry season, however, water is sometimes scarce. In the northern portion of Haywards, a formation of blue clay and rock is struck; there are few good wells in that part of the town, and the water obtained is very hard. There is a streak of water-bearing formation extending through the town in a northwest and southeast direction nearly parallel to the foothills. Along this streak, which does not exceed 20 feet in width, there are many springs, and an abundant supply

of water can be obtained from dug wells at a depth of about 10 feet. At the time of an earthquake, in 1868, a crack opened along this streak, and from it a small stream of sand and water flowed for several hours.

As the valley south of Haywards is entered the depth of the wells increases to 70 or 80 feet, and irregular strata of sand, clay, and gravel have been bored through to a depth of 100 feet. The depth of the wells gradually decreases as the bay is approached, and near the marsh there is plenty of water at a depth of from 10 to 12 feet. At Mount Eden a well which was bored near the railroad station showed the following formation:

Sandy soil	4 feet.
Yellow clay	16 feet.
Blue clay	30 feet.
Blue clay with a few strata of quicksand	260 feet.

Beneath the clay is gravel, with plenty of water.

Upon the completion of this well the water stood within 4 feet of the surface. In the vicinity of Mount Eden plenty of water can be obtained from dug wells at a depth of from 20 to 25 feet. Between Mount Eden and Alvarado a flowing well was obtained upon the Obermiller ranch at a depth of about 300 feet.

The writer is informed that during the last twenty years six or more wells, which yield flowing water, have been bored at distances of less than half a mile in a northerly direction from the Alameda Creek, and that the depth of these wells ranges from 280 to 350 feet.

At Alvarado flowing water is obtained at a depth of something less than 200 feet.

In 1890 a company of capitalists commenced boring a series of wells about three quarters of a mile west of Alvarado, at a point near the Alvarado Creek, formerly known as Union City, their object being to develop a new source of water supply for Oakland and Alameda. The formation penetrated is as follows:

Adobe, soil, gravel, and clay	16 feet.
Yellow clay	40 feet.
Gravel	15 to 20 feet.

This stratum yielded water, which flowed over the casing.

Yellow and blue clay	90 feet.

At this depth a stratum of gravel was struck, yielding a strong flow of water, which flowed 3 inches over a 10-inch casing at the height of 2 feet above the surface of the ground. In some of these wells quicksand was encountered at a depth of about 150 feet. Boring was continued in a southerly direction from the wells, and the formation was found to be similar. No appreciable effect was produced upon the flow of water by increasing the number of wells. There are flowing wells in the vicinity which have been flowing for the last twenty years.

At the date of this writing there are eight flowing wells, which have been bored by the before-mentioned company. Each of these wells is 175 feet deep, and it is estimated that they yield altogether from 4,000,000 to 5,000,000 gallons of water a day. The promoters of this enterprise state that it is their intention to pump the water to an altitude of 120 feet by pumps that will work automatically, and to supply all the water which can be conveyed through a 36-inch pipe to Oakland. Moreover, they state that a sufficient number of wells will be bored to meet the demand for water.

At Newark, about 4 miles south of Alvarado, good flowing wells have been obtained at a depth of about 210 feet. At Mowries, about 2½ miles south of Newark, flowing wells have been obtained at a depth of 220 feet. At the draw-bridge at Alviso flowing water was struck in wells varying from 240 to 250 feet in depth.

Southward from Alvarado the marsh extends farther to the east, and, although flowing wells have not been obtained on the higher ground near Centreville, bored wells are generally from 50 to 60 feet deep, and the water stands at a depth of about 20 feet. The formation is—

Sandy surface soil	10 to 15 feet.
Dry gravel	6 to 8 feet.
Yellow clay	2 to 12 feet.

Beneath the clay is gravel, with a good supply of water.

Toward Irvington the formation is similar, but a short distance south of that village the sandy surface soil gives place to black loam.

THE NEW ROAD.

At the time of the writer's visit to Alameda County a new road was being built up the Arroyo Mocha to the San Antonio Valley. The route selected for this road is less precipitous than that by the way of Crane Ridge. This new road is being constructed so that it will connect with the projected road from the San Joaquin Valley, which is to be made up the Puerta or the Orestimba Cañon, as mentioned under the head of Stanislaus County.

AMADOR COUNTY.

By E. B. PRESTON, E.M., Assistant in the Field.

Coming into the county from the south on the course of the Mother Lode, on the road from Mokelumne Hill, we find on the middle bar of the Mokelumne River, where the black slate crosses, and to the east of the main course of the fissure,

THE HARDENBERG OR CASCO MINE.

The vein has a strike south 13° east, with an easterly dip of about 70°, the foot wall being in black slate, the hanging wall formed by a diabase dike. The property comprises 2,225 feet on the vein by 600 feet wide, and is worked through an incline on the foot wall, sunk to a depth of 600 feet, from whence drifts have been run on the 75-foot, 200-foot, and 300-foot levels. The present owners started on the 400-foot level, drifting to the south 217 feet, connecting by upraise with the level above, and stoping out this block of the vein; the shaft was then continued to the 600-foot level, from whence the vein was drifted on north 201 feet and south 168 feet. At the present time the ore shoot between the fifth and sixth levels is being stoped on the north of the shaft. It pitches to the north and has been developed for 100 feet. The quartz is free milling, carrying about one half of one per cent of sulphurets, mostly iron. The hoisting is done with a Donnelly wheel under a pressure of 270 feet. There appears to be a vein to the east pitching toward the works, which should come together with the other one at a depth of 600 feet. The mill, which is run by a 5-foot Knight wheel, under a head of 330 feet, contains ten stamps weighing 670 pounds, rock-breakers and self-feeders, two Woodbury concentrators and the aprons, 4 feet by 8 feet. The battery is supplied with plates, both on the back and front; the stamps drop ninety times per minute, with a 5-inch drop and 5-inch discharge. The pulp, after passing through a No. 7 diagonal slot-punched iron screen, passes over the aprons into the concentrators, one to each battery; from these the pulp passes into a trap, which conducts it to a pointed box, then through three traps into a final box. One half of the amalgam is retained in the mortar. The concentrators and rock-breakers have a separate Pelton wheel. The concentrates are sent to Sutter Creek to the chlorination works.

Between this mine and the county seat, Jackson, there are, in a width of 3 miles, a series of veins, apparently running side by side. A short distance to the east is a body of gneissoid rock, while on the west side dikes of diabase replace in part the slates. A number of these veins are supplied with extensive working plants, but are mostly idle.

In the vicinity of the county seat to the southeast, the Zeile Mine is running with a crew of one hundred and twenty-three men. This mine is working at a depth of 900 feet. The ore is said to contain 3 per cent

of sulphurets, worked by the company themselves. Information about this property was unobtainable.

THE BELL-WETHER MINE.

This mine is in the immediate vicinity of the town of Jackson, and north of the Zeile Mine. It comprises two claims; the second claim is known as the White, or Austin. Their extent is 1,700 feet each in length, and they are held under a townsite patent on agricultural land.

The vein strikes 35° west of north, with a pitch of 63° to the east for the first 60 feet in depth; deeper it becomes flatter. The width of the vein is 40 feet. The foot wall is black slate, the hanging wall talcose schist; behind the black slate, approaching the west part of the Mother Lode, is diabase.

A three-compartment shaft has been sunk on the pitch of the vein, connecting at 60 feet with a drain tunnel that crosscuts the formation for 200 feet from the surface in to the foot wall. The quartz, while free milling, carries 3 per cent of sulphurets. The mine makes about 300 gallons of water per day.

NEW YORK MINE.

Situated in Sec. 6, T. 5 N., R. 11 E., 3 miles west of Jackson, on the left bank of Jackson Creek; formerly a noted placer mine, known as the John Bull Diggings. It is in slate formation at an altitude of 750 feet above sea-level.

The property comprises 648 acres of ground, with 3,000 feet on the vein. The principal owner resides on the property. The walls of the vein are diabase for the foot and slate for the hanging wall, striking west of north, with an easterly pitch of about 75°. On the top of the hill, where the vein outcrops, an open cut along the vein furnished 2,000 tons of milling ore, at a cost of 80 cents per ton. One hundred and sixty-five feet vertical from the top of the hill is a tunnel 925 feet long, driven on the vein, or more properly speaking, on the quartz overflow forming the cap of the vein. From this tunnel a tramway leads to the mill.

Descending the hill about 60 feet, the lower tunnel has been driven 225 feet on the vein. At the end a station has been made, and a 7x10 perpendicular shaft sunk 50 feet on the vein. A hoisting gear placed at the station is driven by the same 4-foot Pelton wheel that furnishes the power to the mill. At the bottom of the shaft a crosscut 100 feet long has been driven. The vein in the shaft shows a width of 8 feet of quartz.

The quartz, which is free milling, carrying about 1 per cent of sulphurets of iron, galena, and arsenical pyrites, shows in some parts of the vein a most unique feature, in that it contains anthracite particles scattered through the quartz. Several samples that were examined in the State Mining Bureau proved that fact.

The mill consists of a 6-foot Huntington roller mill, with a Huntington self-feeder and rock-breaker, No. 3 size, an apron 5 feet wide and 12 feet long, with a grade of 1⅛ inches to the foot, consisting of separate plates about 1 foot long with ¼-inch drop to each succeeding one. The pulp is passed from the apron through a trap, then over 32 feet of sluices with riffles. The water power is obtained from Jackson Creek, and delivered through 270 feet of pipe under a pressure of 150 feet. The

building is arranged to put up an extra ten stamps, also concentrators, which will be erected this season. The mill crushes 35 tons in twenty-four hours, but for hard rock works better on a capacity of 25 tons. A No. 40 diagonal slot-punched screen is used.

It would appear as if the method of applying the power for both milling and hoisting all from one counter-shaft would cause hinderance and delay, but it is stated that it has not caused any trouble so far.

The mine makes very little water. From ten to twelve men are generally employed, three men running the mill.

North of the town of Jackson and to the west of the Zeile Mine is one of the best equipped and worked mines of this section:

THE KENNEDY MINE

Lies in slate, with prominent quartz croppings on the hill, in the eastern slope of which the two main shafts are sunk. These are 600 feet apart and connected at all levels except the 1500-foot, where they are driving at present to make the necessary connections. The daily ore supply for the mill, requiring over 100 tons, is obtained from the stopes at the 1350-foot level. On the south shaft, at a depth of 930 feet, a crosscut into the foot wall, after passing through 75 feet of the black slate and beyond into the diabase 308 feet, strikes into a large-sized kidney of quartz 2½ feet in average width, carrying gold, but showing no direct connection with the main vein. The length of this body of quartz has not yet been proven; the quartz is being extracted and delivered at the mill. In the reduction of the quartz particular attention is paid to the concentration of the tailings, and with good success.

The forty-stamp mill, with its 850-pound stamps dropping eighty-five times a minute through 6½ inches, discharges over 7 inches through a No. 30 brass wire screen, from 2½ to 3 tons a day to the stamp. The pulp is conducted, after passing over aprons 2 feet by 5 feet, through 14 feet of sluices provided with plates, onto the concentration tables, two of which are provided for each battery; from these the pulp is distributed over canvas platforms. The tailings are then made to pass through two pointed boxes, freeing them from the coarse sands, and after being diluted by the addition of clear water are conveyed onto a second canvas plant, consisting of twenty tables, 10 feet by 12 feet, set at a pitch of 1½ inches to the foot, side by side, in two series of ten tables; each table in the series is placed 4 inches below the preceding one. At the head of these tables runs a wide sluice, partitioned lengthwise into ten divisions in such a manner that each division ends above one of the tables consecutively, so that an equal amount of the diluted pulp passes over each table. At the foot are two sluices, with a swinging board attached in such a manner that the pulp passing over the table is delivered to the one, while the concentrates are washed into the other. The tables are cleaned eight times in ten hours by shutting off the pulp and washing down the table with a hose supplied with a nozzle throwing a flat stream. The pulp thus shut off goes to the twentieth table, to prevent an uneven flow over the remaining tables. The concentrates gathered in the sluice below flow into a long box, where they are roughly sized, then passed for further cleaning over a corrugated shaking table, and the waste from this allowed to pass over a final third canvas platform. By this method sulphurets are saved that float off on the top of the water. But it is well to bear

in mind that even with this elaborate system all the concentrates are not saved; the most thorough workings of this description cannot economically reach higher than 87 per cent of the material to be saved, and in many cases not that high. A good many mine owners are deterred from permitting outside parties to work their tailings, under the false impression that it implies careless work on the part of the mill for anything to be found in their waste, whereas the fact is, there is an economic limit, beyond which it does not pay to work. This percentage is circumscribed by the question of dollars and cents.

The Kennedy Mine works are run by 150 inches of water taken from the Amador Canal and delivered at the two hoisting works under a pressure of 150 and 175 feet, and at the mill under a head of 200 feet, acting on Pelton wheels. At the hoisting works they are supplied with steam power for reserve. One hundred thousand gallons of water flow into the mine daily, that are handled by skips holding 500 gallons each.

Of the two shafts, the north one is sunk on the vein vertically for a depth of 400 feet, continuing at an angle of 66° with the pitch of the vein. The south shaft is sunk in the foot wall slate. Drifts are run in the mine for $4 a foot. The company has erected a 3-ton chlorination plant. At the present time seventy men are employed in and around the works, the average wages being $2 50 and $2 75 per day. The vein shows the black slate gouge and the contact with diabase. Both east and west at a distance of 5 miles is a limestone belt.

CLINTON CONSOLIDATED MINE.

About 8 miles northeast of Jackson, out of the general course of the black slate belt, are two veins, the Paugh and the Union, striking northeast and southwest, and dipping to the west. The Union has the characteristic gouge. The Paugh, pitching flatter than the Union, comes together with the latter above the shaft. The developments include both tunnel and shaft. The tunnel, which is over 1,000 feet long, runs in on the gouge vein, which at the connection above the Union shaft cuts the latter vein off. The vein is 34 feet wide. The country rock is black slate, traversed by porphyritic dikes. The whole neighborhood has yielded largely in placer gold.

The Union shaft is sunk 289 feet on an incline of 56°, and is provided with a double car track. Two levels have been driven, one at a depth of 100 feet, and again near the bottom. The ore, after being hoisted out of the mine, descends a slope 800 feet long to the mill level. The hoisting is done with steam power, on a double reel, using a ¾-inch steel rope. Cord wood is supplied at $3 50 per cord.

The mill contains thirty stamps; of these twenty weigh 1,000 pounds and the other ten 850 pounds. It is the intention to add ten more stamps. They are all supplied with steel shoes and dies, delivered at the works for 9 cents a pound. The mill is run at a speed of one hundred and four drops per minute, with a 6½-inch drop, and 8-inch discharge through a No. 20 brass wire screen. The battery is provided with plates both in front and at the back, and it is claimed that nearly all the amalgam is retained in the battery. The mill crushes an average of 3 tons to the stamp. The pulp passes over a 2-foot by 5-foot apron, and 16 feet of amalgamated copper plates. The concentration is performed on eight Frue vanners; six more of these are to be added.

A chlorination plant of 3 tons capacity is run about ten days every two months.

The power for the mill is obtained from the Volcano ditch, through 1,450 feet of pipe-line, giving 360 feet of pressure. This water, after being used at the mill, is carried down the hill and used to drive a compressor plant running three Ingersoll drills. The compressed air for this purpose is forced half a mile up the hill.

The mine makes 7 miner's inches of water, which is removed with a steam pump, but a Cornish plunger pump is to be substituted. The ore is free-milling quartz, carrying one half of one per cent of iron sulphurets, with galena and occasional tellurides.

Twenty-eight men are employed; of these, miners receive $2 50, outside men $2, mill men $4 and $3, concentrator $3, and helpers $2.

A ranch of 3,500 to 4,000 acres, situated in T. 6 N., R. 12 E., comprises part of the property, which likewise includes store, assay office, boarding house, dwellings for the men and the management, etc. The company have had possession during the last three years, in which time they have made many improvements. A timber yard was being prepared just above the level of the track last season, and the roads improved.

About 4 miles east of here the main granite country of this part of the Sierra Nevada Mountains commences.

Returning to the course of the Mother Lode and passing north we notice, in the neighborhood of Sutter Creek,

THE SUTTER CREEK MINE,

Now called the Belmont, near the Wildman, and north of the South Spring Hill and Keystone Mines. The Mahoney and Lincoln claims are on the south and north borders. It contains 1,100 feet by 400 feet. For years the croppings have been worked and have paid well. The vein is from 20 to 30 feet wide between slate walls, dipping almost vertically. About 150 feet east of the slate is a diabase dike. Two shafts are sunk on the vein; the northern one to a depth of 200 feet, the one to the south 75 feet. From the latter a 240-foot level is run off to the north. A tunnel 650 feet in length, 7 feet in the clear, runs from the mill to the big ore body and cuts the shaft at a depth of 45 feet. At the present time they are sinking the north shaft with the idea of opening a drift on the 300-foot level. The hoisting is done at present with a patent whim by horse power, but a steam hoist is being prepared.

A ten-stamp mill on the property, run by water power from the Amador Canal, uses 50 inches of water at a cost of 20 cents per inch, under a 100-foot pressure, on a 4-foot Knight wheel. It has 850-pound stamps, dropping 6 inches ninety times per minute, with a 5-foot apron and 12-foot sluice plate. An English buddle works the sulphurets, of which the ore contains an average of 2 per cent.

One of the largest expenses connected with the running of these mines is the procuring of timbers and lagging. The supply is hauled 20 miles and is sold according to size; for 3 inches, 4 inches, and 5 inches at the small end, 50 cents per foot is charged; for 6 inches at small end, 75 cents per foot; for 7 and 8 inches, $1; for 20 inches, $4 50 per stick. For lagging the price is $70 per thousand feet.

THE WILDMAN MINE.

Since the issuing of the last report the main shaft has been sunk 200 feet deeper, being now down to the 900-foot level. At the 800-foot level they have driven 400 feet and stoped on a length of about 40 feet. At the 900-foot they have drifted south 300 feet on a fair lode, and are stoping from there.

The inflowing water amounts to a steady stream of 3 miner's inches, which is controlled by three Cornish plunger pumps and a hydraulic lift; the latter uses 9 inches of water. The cost of the water is represented by a charge of $2 50 per day and the wages of one pump man at $3 per day. The water power is derived from the Amador Canal Company and used under a pressure of 480 feet. It is conveyed through two strings of steel pipe, No. 11 and 13, each 5,000 feet in length, costing $17,000. Eleven Knight wheels are used in and around the works, varying from 4 to 6 feet. A new sawmill has been erected, carrying two saws and a patent knife. A $300 derrick has been put up in connection with it to handle the saw logs. One man and a boy attend to the sawmill.

The shaft is to be sunk 100 feet deeper, and a new dump built. At present forty-eight men are employed. The mill has been enlarged by the addition of ten stamps, eight Frue concentrators, and four Challenge ore feeders, and has a present capacity of 70 tons. The Phœnix machine drill is used in the stopes as well as in drifting.

THE SUMMIT MINE,

Owned by Messrs. John and J. R. Tregloan and the heirs of Mr. Stewart, lies next to the Eureka Mine and joins the South Eureka on south; the ground is patented and contains a full claim of 1,500 feet by 600 feet. A two-compartment shaft was sunk on the vein 600 feet. The property was closed by litigation twenty-four years ago, but will now be opened and worked by the present owners. The last rock worked in this mine paid $37 per ton. The mine is on the main road to Ione, and well situated for obtaining water or electrical power.

SOUTH EUREKA MINING COMPANY

Joins the Summit on the south and the Oneida on the north. The claim consists of 160 acres, with 2,000 feet on the course of the Mother Lode and 2,400 feet wide. A three-compartment shaft 7½ by 14½ feet has been sunk 540 feet. On the 500-foot level crosscuts have been driven 110 feet east, 40 feet west, and 28 feet south. Several good stringers of quartz have been developed, but no large vein, although the indications are favorable in that direction. The hoisting is performed either by steam or water; the power is conveyed by cable a distance of 550 feet. The water power is applied on two 6-foot Donnelly wheels under 185 feet of pressure, using 14 inches, at a cost of 20 cents per inch.

The shaft was sunk in the slate between the walls about 200 feet from the diabase on the east. The company is working a force of thirteen men at present.

THE HECTOR MINE,

Just north of the Wildman Mine, in Sutter Creek, is preparing to resume operations. They are hoisting the water out of the main shaft; the present water-level stands at 450 feet from the surface, and the shaft is over 1,000 feet deep. Preparations are being made for the erection of a new forty-stamp mill completely equipped with shaking tables and canvas platforms, also to retimber the mine. In the meantime the old mill is to be started. Nine men are employed in the works at present. In this mine the vein has been worked along the whole line of the strike from the surface down.

SOUTH SPRING HILL.

This company's property includes the Talisman and the Median; 60 acres in all on the Mother Lode, including some agricultural land. The work is confined to the Talisman and the South Spring Hill. The vein is on the west side, between the diabase and slate. Since the mine was last reported on, some of the drifts have been extended, and the motive power changed from steam to water, the machinery for the former, however, being retained as reserve force in case of need. A new main working shaft near the center of the claim is to be started shortly. The mill is supplied with Frue, Woodbury, and Triumph concentrators, and all the works above ground are supplied with electric lights. The work underground is carried on entirely with machine drills, using different patterns. The mine employs seventy men at present.

KEYSTONE MINE.

On the west side of the Mother Lode, in the black slate in Amador City, the diabase being not a great distance to the west. There are several veins in the claim, that on the foot wall having given the best results. The mine at present is not running to its fullest capacity, only twenty-five of the forty stamps dropping. From the 1200-foot level a winze has been sunk 132 feet by the aid of a small engine placed in the level; this is to be continued down another 100 feet. The present ore supply comes from the 600-foot level. No northwesterly developments have been made. The present force consists of sixty-eight men.

QUARTZ MOUNTAIN MINE.

Between 2 and 3 miles northeast of Amador City and about a mile to the east of the Mother Lode, on Rancheria Creek, is a hill known as Quartz Mountain, the top of which shows a large overflow and outcrop of quartz in gneissoid rock, dipping apparently to the northwest, rather flat. The vein is about 10 feet thick. The quartz is free milling, though carrying in part arsenical pyrites, and also galena. It is entirely different from the Mother Lode quartz, and the bullion obtained in the mill is nearly half silver. The surface quartz is sufficient to run a forty-stamp mill for a year or more.

The mill is situated at the foot of the hill, on the north bank of the creek, and is outfitted with a thorough concentration plant, consisting of Woodbury concentrators, canvas plant, and settling boxes. Mine and mill are connected by a gravity tramway.

THE GOVER MINE.

The mine contains two bodies of ore, separated partly by slate, but in some parts of the mine with nothing but a gouge between them. The west wall is slate, the east diabase. The mine is on the west side of the main fissure, two other veins of quartz showing to the east.

Since the very thorough report on this mine in the year 1888, the shaft, 12 feet by 13 feet, has been continued to the 1200-foot level, at an angle of 50°, and is showing favorably in the bottom. It is sunk all the way in diabase. On the 500-foot level the drift has been run south 300 feet and north 262 feet, showing a vein from 20 to 50 feet wide. On the 600-foot level to the south the drift extends 600 feet, and to the north 75 feet, showing a vein from 30 to 40 feet wide. On the 700-foot level the drifts north and south are respectively 400 feet and 300 feet, with a vein varying from 15 to 60 feet in width.

The ore is being stoped at the seventh and eighth levels, and a new station is started at the 1100-foot level. The water, at the rate of 75,000 gallons a day of ten hours, is hoisted out of the mine with electric pumps, one being placed at the 700-foot level, the other at the 400-foot level. The power is equal to fifty horse-power, but only thirty-five horse-power is required. The pumps are run eight hours per day.

A large amount of prospecting is being done; the rock is rich in pockets; stringers running into the diabase are sometimes quite rich. The company is employing from forty-five to fifty men; twelve of these are employed in sinking the shaft.

The mill and dynamo are run by water power. A 3-foot Dodds wheel, under 278 feet of pressure, is used for the mill, and a Pelton wheel for the dynamo. The water is brought from the Blue Lakes. For the mill 45 inches are required and for the dynamo 50 inches. The mill crushes 3 tons to the stamp, using Woodbury concentrators, one to each battery, and 100 feet of canvas tables, after which the tailings are run to wooden tanks to settle, the settled material being passed again over a Woodbury concentrator. The final tailings are stated to assay not more than 50 cents to the ton.

The North Gover Mine has merely sunk a short distance in their shaft.

From the mines around Plymouth but little information could be gathered. About twelve men are doing some prospect work at the Empire Mine.

THE BAY STATE MINE.

This is a new enterprise, working on the Mother Lode 4 miles north of the Empire Mine, with about twelve men. A shaft has been sunk 300 feet and a crosscut is being driven. So far they have passed through 14 feet of quartz and are still driving ahead through vein matter.

COAL AND CLAYS IN AMADOR COUNTY.

By W. L. Watts, Assistant in the Field.

Borings in the portion of the foothills of Amador County visited by the writer show a large amount of lignite, as yet untouched, which must eventually find its way into the market.

The physical appearance of the specimens of coal from the Newman ranch, as compared with the coal now mined near Ione, would indicate it to be of a different quality. The comparative analyses made by Dr. W. D. Johnston, the Chemist of the Bureau, are as follows:

	Moisture—Per Cent.	Volatile Carbonaceous Matter—Per Cent.	Fixed Carbon—Per Cent.	Ash—Per Cent.
Specimen from No. 3 Mine of Ione Coal and Iron Company	13.25	49.00	27.25	10.50
Specimen from boring on Newman Ranch	15.00	37.75	38.50	8.75
Specimen from Wardell Mine, Lancha Plana	15.25	34.00	28.75	22.00

The presence in the same locality of a large supply of fuel, together with pottery clay, and sand, which is said to be suitable for the manufacture of glass, will, no doubt, in course of time, be taken advantage of, and the prospectus issued by the Carbondale Coal, Land, and Improvement Company shows that they have this end in view.

THE SACRAMENTO AND IONE COAL COMPANY.

The mine operated by this company has been worked continuously for ten or twelve years; from it upwards of 24,000 tons of coal have been taken out during the last two years. There are two grades of coal sold from this mine, the sorted and the unsorted. The sorted coal is used principally for domestic purposes, and has commanded a price of $3 per ton at the pit's mouth; the unsorted is used as steam coal, and its price at the pit's mouth is $2 per ton.

Mining operations during the last two years have shown this coal vein to be from 6 to 24 feet in thickness, the head wall being a light brown clay and the foot wall a tough white fire clay. The coal appears to lie in a basin, the deepest portion being about 75 feet from the surface of the ground, rising at the edge to about 20 or 30 feet from the surface; the whole basin occupies an area of some 15 acres. This coal, as is well known, is a light variety of lignite, and is supposed to be of late Pliocene, or even more recent age. Pieces of resin are frequently found amongst the coal. For further description of these mines, see Eighth Annual Report of the Bureau.

THE IONE COAL AND IRON COMPANY.

The No. 3 Mine, belonging to this company, was opened about seven years ago, and has been worked continuously until the present time. A large amount of coal has been shipped to Stockton, Sacramento, and elsewhere. It is also used entirely upon the railroad between Ione and Galt. During the last two years an average of 100 tons of coal per day have been raised from this mine, about twenty-five men being employed. Work is carried on only during the day time. The vein is from 5 to 15 feet in thickness, and appears to be practically horizontal. Both walls are clay; the head wall being light colored and the foot wall somewhat sandy. The coal resembles that of the Sacramento and Ione Company, and commands about the same price in the market.

THE CARBONDALE COAL, LAND, AND IMPROVEMENT COMPANY.

In 1890–91 a shaft was sunk at Carbondale by this company to a depth of 60 feet. Various strata of light-colored clay were passed through, and 18 feet of coal. A drift was run in the coal for about 30 feet. Much water is said to have been encountered, which required a No. 5 Pulsometer pump to control it.

In 1891 another shaft was sunk for the same company, about a mile from the shaft above mentioned. The formation is as follows:

Pottery clay	45 feet.
Quicksand	2 feet.
Pottery clay	50 feet.
Coal	8 feet.
Clay and carbonaceous matter	20 feet.

The coal was drifted on for 150 feet to the west, 100 feet to the south, and 50 feet to the north, without any change in the formation. A No. 3 Knowles pump easily controlled the water. The shaft was timbered with 6x4 timber, but the drifts stand without timbering.

COAL ON THE NEWMAN RANCH.

In September, 1891, experimental borings were made on the ranch of J. Newman, Sec. 20, T. 7 N., R. 11 E., M. D. M., about 3½ miles from Carbondale, which showed:

Soil	2 feet.
White clay	4 feet.
Reddish clay	8 feet.
Sand	3 feet.
Dark sand	2 feet.
Dark clay	3 feet.
Dark and light clay mixed	4 feet.
White clay	4 feet.
Dark brown clay	1 foot.
Coal	8 feet.
Black clay	2 feet.
Pottery clay	20 feet.
Coal	5 feet.
Soft brown clay	8 feet.
Hard brown clay	7 feet.

In 1891 an old shaft on the Newman property was cleaned out; it is about a quarter of a mile northeast from the boring. A similar formation to that above noted was passed through for 24 feet, at which depth the coal was found to be 6 feet in thickness. Samples of this coal shown the writer were somewhat lustrous, blacker and heavier than the coal now mined at Ione. Other borings in the same vicinity are said to have shown similar results.

WELL WATER.

A well was bored near the Carbondale Post Office, which showed:

Soil	2 feet.
Sand and gravel	17 feet.
This stratum yielded some water.	
Coal	13 feet.
White sand rock.	

The water stood at about 9 feet from the surface.

THE CARBONDALE POTTERY.

This property is owned by F. Hammer, and it has been in operation since 1877. At these works, vitrified sewer pipe, stone and terra cotta, are manufactured. One circular, down-draught kiln is in operation, the diameter of which is 14 feet in the clear. The clay used comes from the property of Mr. Hammer at Carbondale; he also sells clay to other parties.

CLAY.

As described in our Eighth Annual Report, large quantities of clay are shipped from Carbondale and vicinity; and the writer was informed that during the two years ending May 1, 1892, more than 800 carloads of clay had been shipped from these deposits. The principal shippers were F. Hammer, of the Carbondale Pottery, and the Ione Coal and Iron Company.

Mr. F. Free, of Ione, has also opened a clay bank on the property of the Ione Coal and Iron Company at Carbondale. The clay bank has been prospected to a depth of 10 feet from the surface, and two carloads of clay have been shipped to Tracy Brothers, of the Mission Pottery Works at San Francisco, who have pronounced it of good quality. The clay crops out at the surface of the ground a few feet from the railroad track, and only requires from a few inches to 2 or 3 feet of stripping. Mr. Free states that he is prepared to make contracts for his clay in large shipments at 80 cents a ton, f. o. b. at Carbondale.

WHITE SAND.

There is said to be a large deposit of white sand on the ranch of J. B. Williams on the S.W. ¼ of Sec. 18, T. 7 N., R. 9 E., M. D. M.; and that borings on the property of the Carbondale Coal and Land and Improvement Company penetrated strata of white sand from 20 to 50 feet in thickness, at a depth of from 50 to 100 feet from the surface. It is claimed that analysis of this sand has shown it to be suitable for glass making.

THE O'NEAL SANDSTONE QUARRY.

Work was suspended at this quarry at the time of the writer's visit. A breast of about 20 feet is exposed, the stone being a compact and evenly grained sandstone of a reddish brown color, passing into light brown and white. The strata are practically horizontal, with probably a slight pitch to the northwest. Some of the sandstone showed imperfect casts of turritella, and a small sized pecten, but they were too imperfect for identification.

THE ARROYO SECO GRAVEL MINE.

Work was continued at this mine during the summers of 1891–92, seventeen or eighteen men being employed. The machinery used, and the method of washing, were similar to those described in our Eighth Annual Report. The total output for the last two seasons has been $30,000.

BUTTE COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

The entire eastern side of this county is formed by outrunning spurs from the western side of the Sierra Nevada Mountains, between which the different branches of the Feather River (North, Middle, and South, with their tributaries) debouch into the Sacramento Valley, after passing for the greater part of their course through a rich mineral country, in which gold-bearing quartz veins, as well as remains of ancient river channels, are abundant. These spurs contain an abundance of timber suitable for mining, while the south and west parts of the county contain as rich farming land as can be found anywhere in the State, insuring an unfailing source of supplies for the support of large bodies of miners. Railroads extend up to the county seat, and good stage roads penetrate the foothills in different directions.

As a large part of the gold production of Butte County has been derived from the Feather River and its branches, which unite about 10 miles north of Oroville, the county seat, more capital has been expended in this branch of mining of late than in the development of the drift or quartz mines. Work of an extended nature in this direction has been brought to a close by two English companies, the Golden Gate Channel River Mining Company (limited), and the Golden Feather Channel River Mining Company (limited), on the main Feather River, just above Oroville, under the management of Col. Frank McLaughlin.

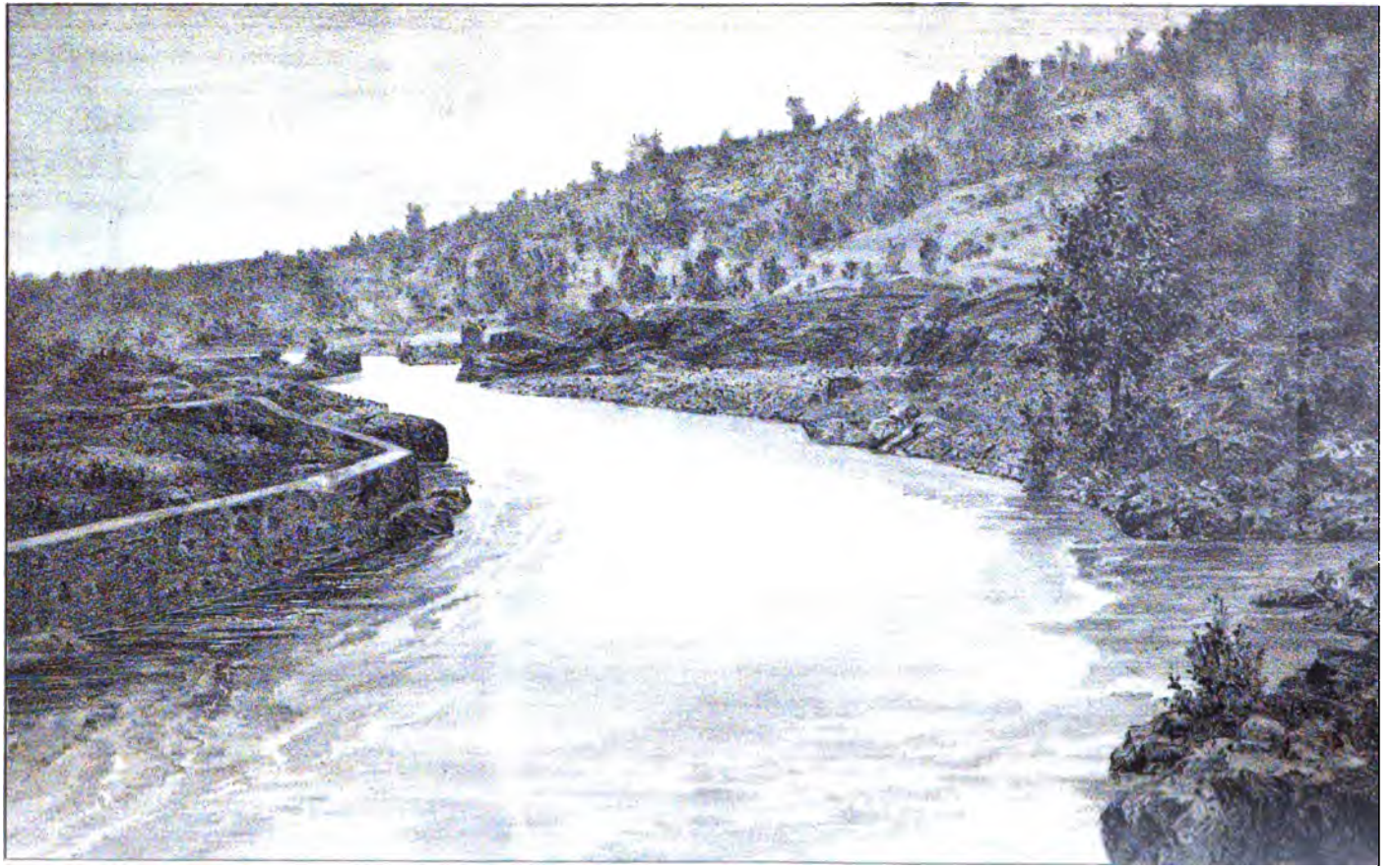
Of new developments in vein mining the most notable are on the Forbestown Ridge, while the successful reopening of the famous Perschbecker Mine, on the Dogtown spur, with other drift mines in this vicinity, bids fair to make that section prominent.

Immediately above the town of Oroville, which is built on auriferous gravel, are situated the two river claims previously referred to, which are of importance to the whole county, aside from their possible gold yield, as they furnish permanently a constant water power of four thousand horse-power in the immediate neighborhood of the town and railway, offering unequaled advantages for manufacturing establishments.

THE GOLDEN FEATHER CHANNEL COMPANY (LIMITED).

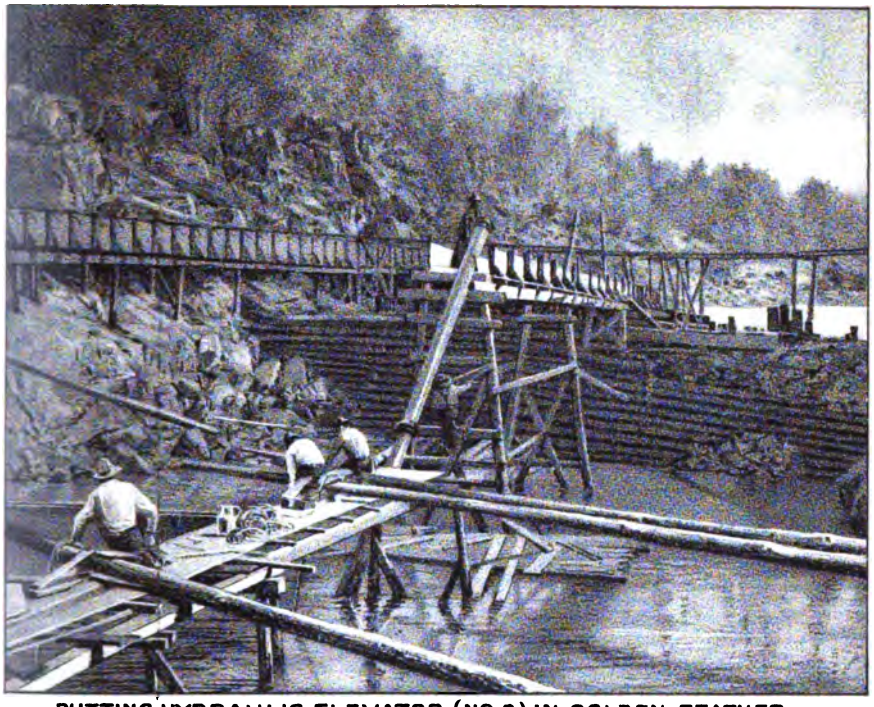
This is the first of the two river claims that are to be operated by English capital, and is situated on the Feather River, immediately above the Oroville bridge.

A vast amount of preliminary work has been required to insure the work to be carried on, comprising the building of 10 miles of substantial roads; the providing of dwellings in three separate camps capable of accommodating from one hundred and fifty to three hundred men, besides the necessary workshops; also the building of a canal along the right bank of the Feather River, 40 feet wide and 6,000 feet long, requiring excavation of 50,000 cubic yards, to carry the river when turned out

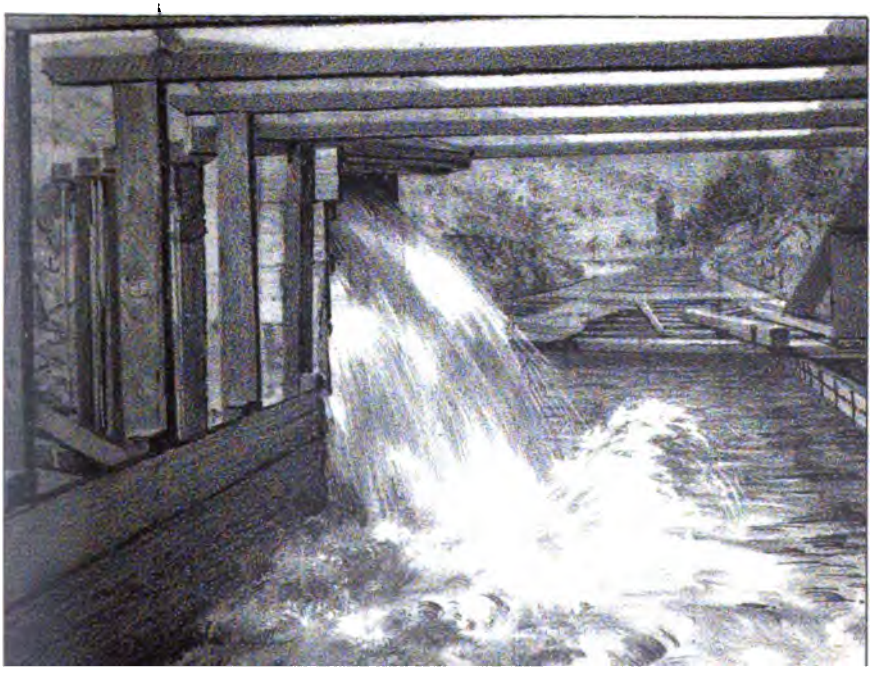


AT WORK ON HEAD DAM OF GOLDEN FEATHER.

SUB-FLUME ABOVE HEAD DAM SITE OF GOLDEN FEATHER CLAIM.



PUTTING HYDRAULIC ELEVATOR (NO. 2) IN GOLDEN FEATHER.



of its natural bed; the construction of a permanent head dam; the procuring of power, which was obtained by repairing the old Miocene ditch, which required 5 miles of iron piping; also the erection of an electric plant, to enable the work to be carried on by night as well as by day, and the connection of all the different points and the ditch stations with the head offices by telephone, requiring over 40 miles of telephone wire.

In the construction of the canal, a cemented rock wall was carried along the entire distance next the river, at a width of 4 feet on top and 12 feet on the bottom, reaching, in places, a height of over 20 feet from bedrock, containing over 10,000 cubic yards of masonry; in the construction of which 6,000 barrels of Gillingham cement were consumed, costing $4 68 per barrel laid down at the works, bringing the cost of the wall up to $7 50 per yard. In this work the masons employed received an average of $3 per day; blacksmiths, from $3 50 to $4; rock excavators, according to the hardness of the rock worked on, 80 cents, $1 50, and $2 per cubic yard.

Two suspension bridges cross the canal, giving access to the work from the shore. One of the bridges is 80 feet long, carrying the pipe-line across that conveys the water power from the Miocene ditch; a diminishing iron pipe is made use of, receding from 32 inches in diameter to 22 inches, constructed out of No. 14 and No. 12 iron. The company have the use of 1,000 inches of water, in return for repairing and keeping the ditch in order.

The permanent head dam extends from a rocky point at the foot of South Table Mountain, to a high mass of rock near the middle of the river, and from there to the opposite shore. The first 120 feet next to the west bank is occupied by the fore bay of the canal and a side dam 70 feet long providing for the waste way. The main dam is about 144 feet long, and consists of cribs of peeled pine poles from 10 to 12 inches in diameter, spiked together with wrought-iron spikes (three tons were used in the construction), and filled with the heaviest rocks that the derricks could handle, quarried out of the river banks; all surmounted by framed timbers 8x8 inches, and crowned with a shelter dam that can be raised or lowered. This latter provision is made to meet any unexpected rise in the river. It required 70,000 feet of round timbers and 6,000 cubic yards of rock in the construction, and has a height of 52 feet. The water slope is doubly planked with 2-inch boards. The upstream slope is boarded and made tight by sluicing in sand, earth, and gravel from the banks. The dam is provided with a water cushion, and everything done for the security of the work that knowledge and experience could suggest.

To prevent damage to the head of the canal by the waters coming down Morris Ravine in the spring of the year, it became necessary to wingdam the mouth of that gulch. A sub-flume is built along the east bank, discharging over the end dam.

Two hydraulic elevators are used, which are supplied with power from a reservoir in the adjoining hills, whose lifting power with 1,000 inches of water under a head of 480 feet amounts to 540,000 gallons an hour, discharging into the sub-flume. Two hundred cubic yards are raised by the larger elevator per hour, on a slope of 42°, to a height of 55 feet. The elevator is 20 inches in diameter, with a 4½-inch nozzle.

The gold found in this part of the river during the preparatory work

along the rim is fine and thin, somewhat like cucumber seed, and sells for $18 50 per ounce.

The accompanying contour map and photographs of the dam and canal will convey an idea of the magnitude and solidity of the work undertaken.

THE GOLDEN GATE CHANNEL MINING COMPANY.

This property, like the preceding, on to which it joins, is intended to work a part of the bed of the Feather River, but as the conditions are somewhat different, the channel being confined between steeper and more contracted banks, in place of a canal to carry the river, a flume has been constructed at an elevation of 90 feet above the bed of the stream, dropping it at the end of the claim into the canal of the Golden Feather Company.

The head dam of this claim is situated at Long Bar, about 2½ miles above Oroville, and has a total width from bank to bank of 374 feet, and a height of 52 feet. It consists of cribs filled with large-sized rocks chinked in solid with smaller gravel. In the construction 45,000 feet of round timbers were used, and 20,000 tons of rock, besides 3 tons of spikes. The flume starts on the west side of the dam, and commences with a width of 80 feet, decreasing in the following 300 feet to its normal size of 40 feet, which it retains throughout its entire length of 3,900 feet. An extension flume carries the water to the Golden Feather Channel Company's canal.

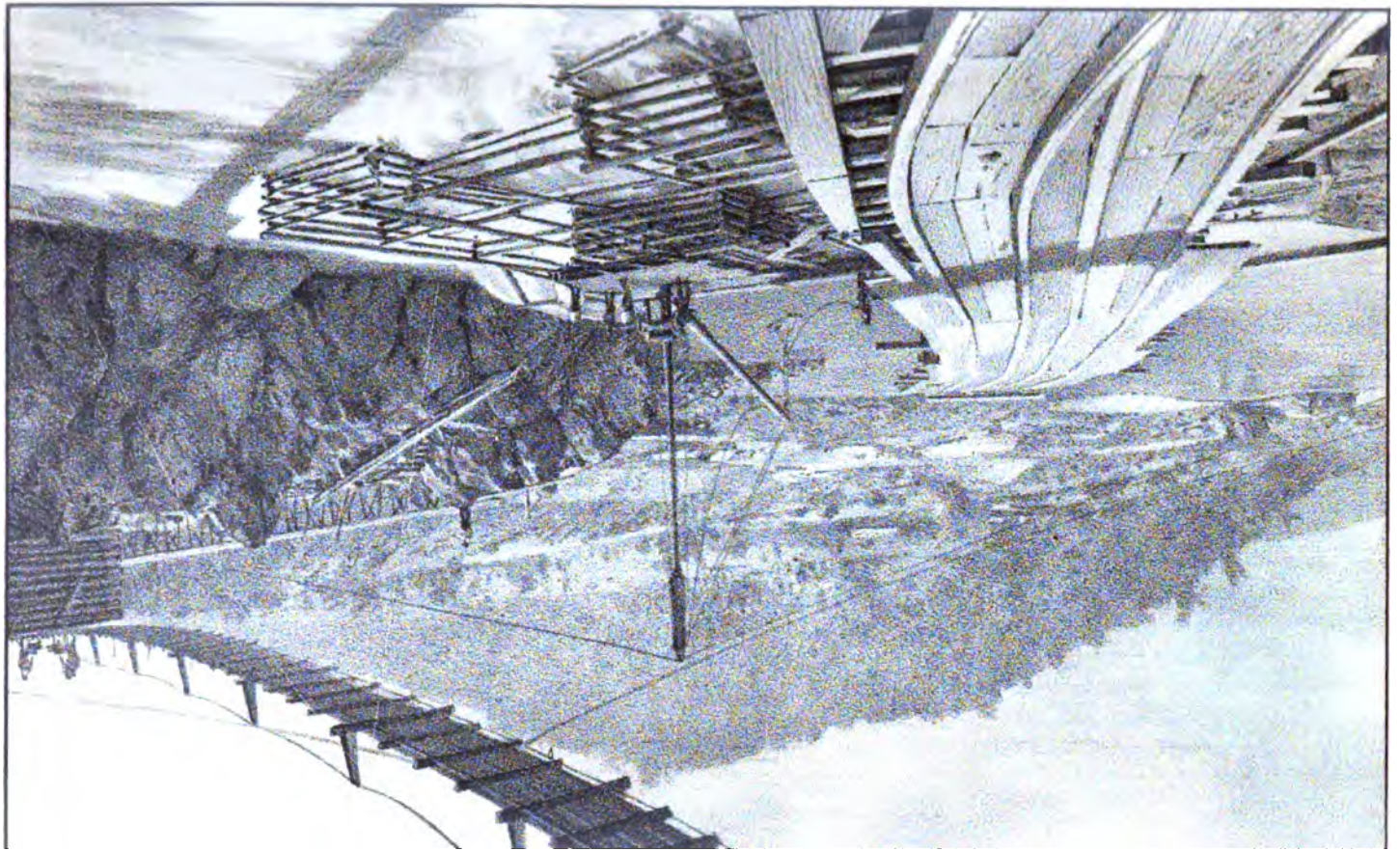
In the construction of the flume, 1,250,000 feet of lumber was used, costing from $14 to $18 per thousand. The posts average 12 inches at the butt, running to 8 inches in the taper. Five stringers of 8x8-inch spruce timber held the 6x6-inch cross-ties, placed 4 feet apart. The bottom and sides are formed of 1½-inch boards, the sides being 5 feet high. The mortised side posts are made of 4x6-inch stuff, held together with 4x4-inch braces. Each piece is marked and everything so arranged that in case of a sudden rise in the river, the entire flume can be removed inside of forty-eight hours.

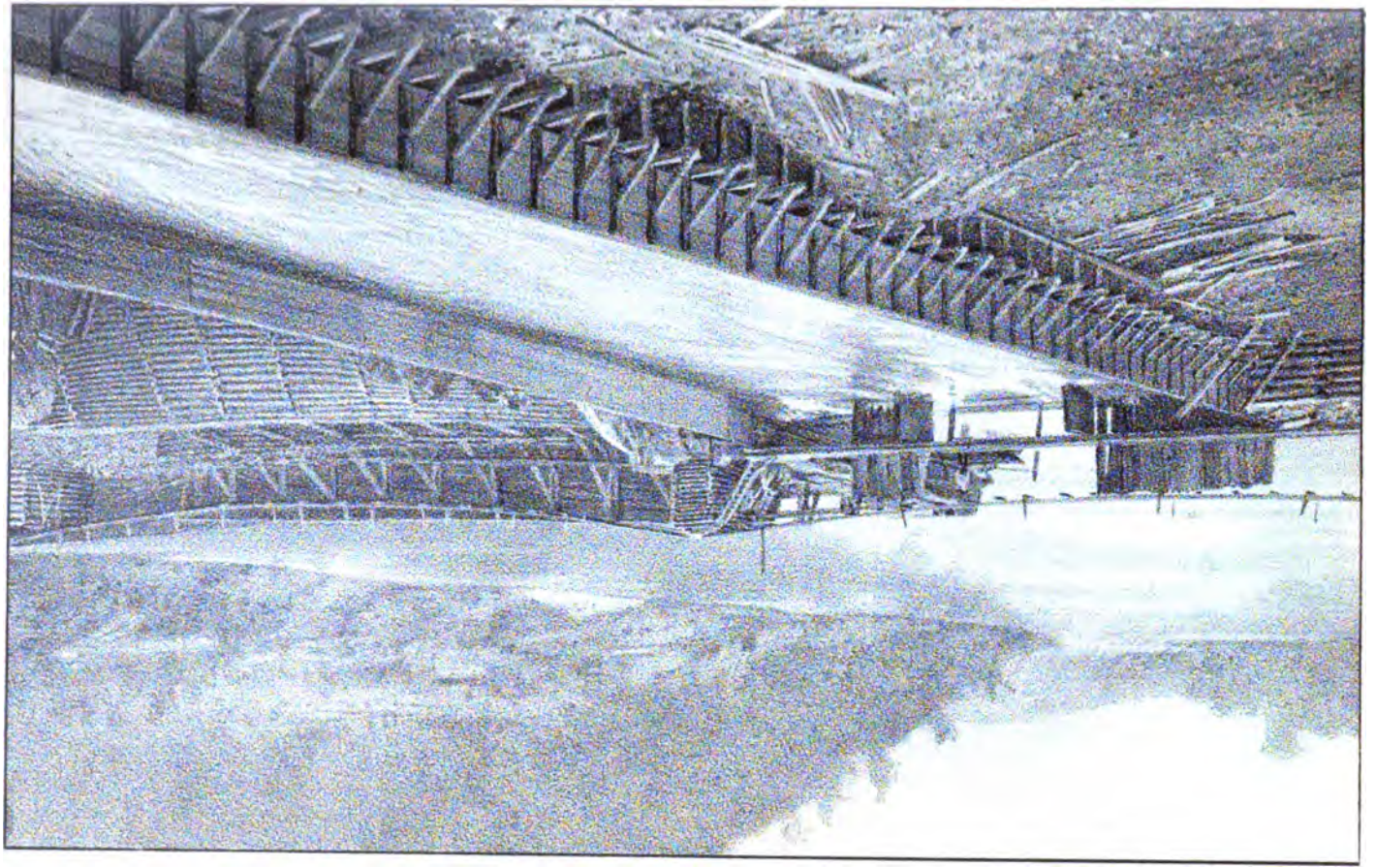
The water flows though the flume at an even grade of one inch to the rod. At extreme low water it flows 2½ feet deep, with a velocity of 18 feet per second, indicating a flow of 1,440 cubic feet per second, or 72,000 miner's inches, under a 4-inch head. Last year it carried 125,000 miner's inches, being the largest amount of water ever carried by a flume. The dam raises the water to a depth of 50 feet, and backs it up for a distance of 7 miles.

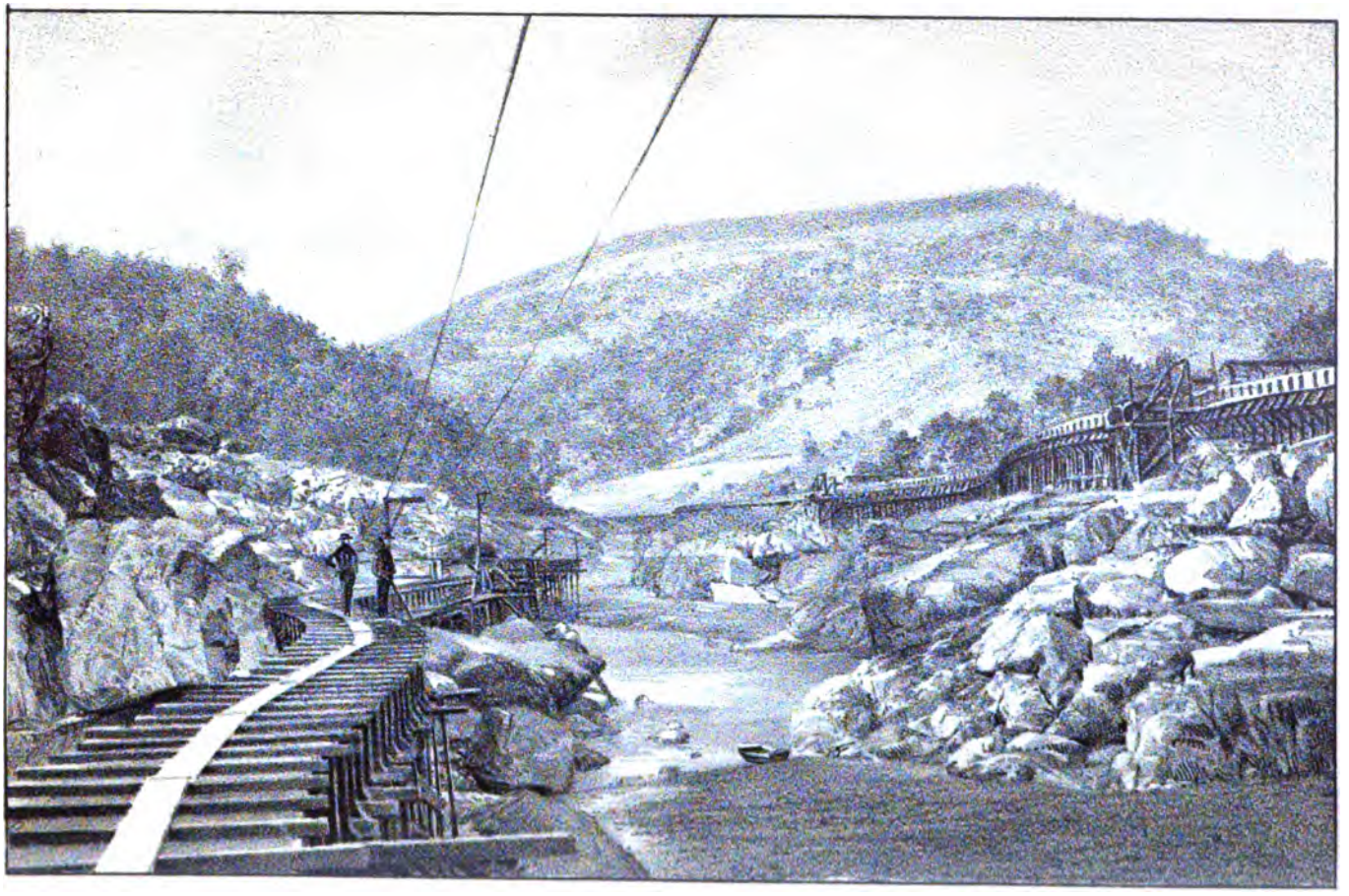
Powerful wheels will be used to run the pumps in getting rid of the seepage and the dead water between the head and foot dams, which is passed into a sub-flume 8 feet wide, with a grade of one quarter inch to the rod, carrying an average depth of 3 feet of water.

Unlike the Golden Feather Channel Company's ground this part of the bed of the river was found to be covered by debris to a depth in places of over 40 feet, which will all have to be removed before the pay gravel in the bottom can be handled. Work will be carried on day and night with the assistance of the electric light. During the season of low water as many as five hundred men are employed in these two mines.

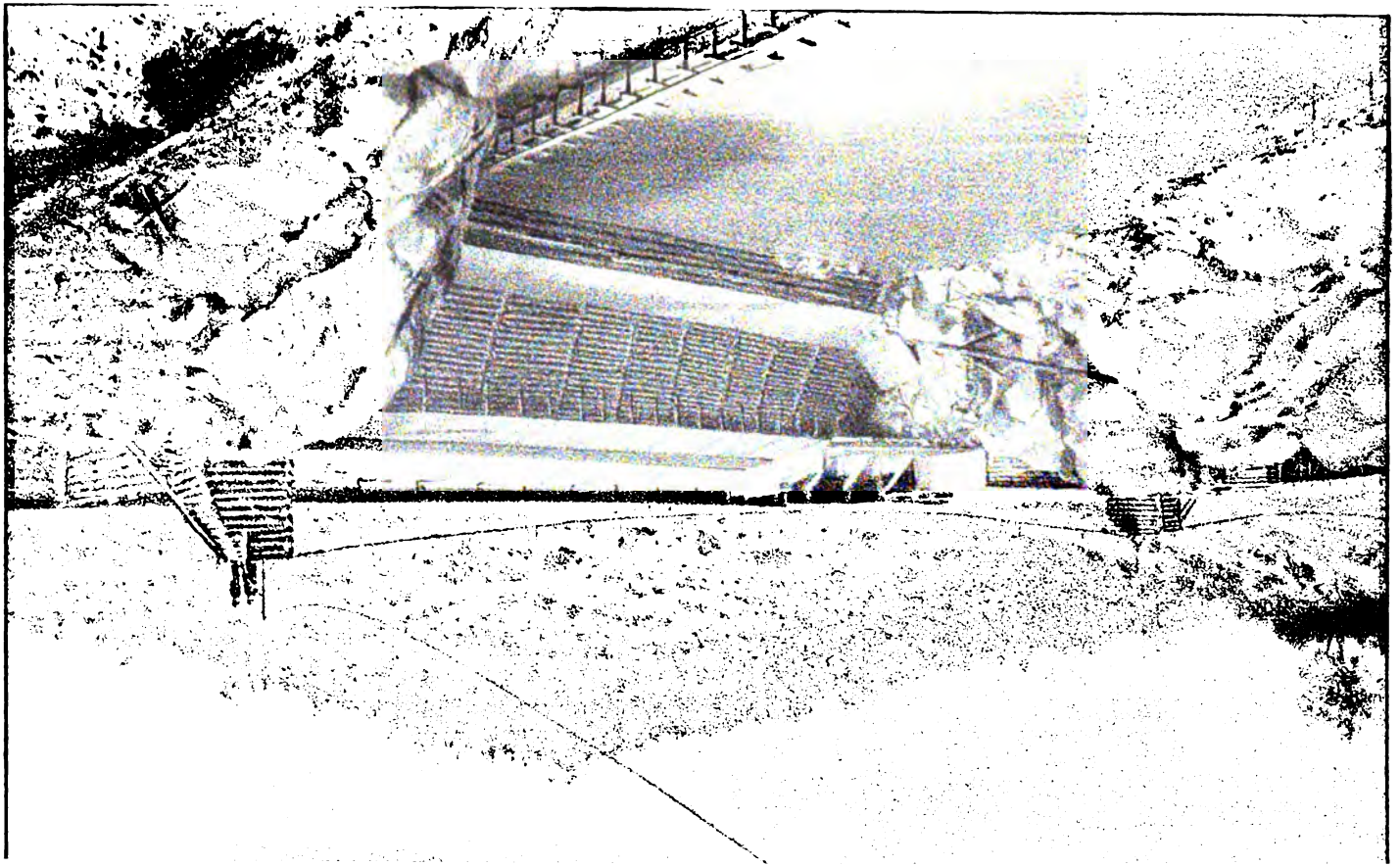
The average depth of the pay gravel in these mines is about 4 feet. The bedrock is diabase. The average working season is estimated







SOUTH TABLE MOUNTAIN, WITH VIEW OF CHANNEL, LOOKING DOWN STREAM.



between four and five months, but varies with the length of the winter and the amount of snow that falls in the upper drainage area of the river. The wages paid for common white laborers is $2 50 per day; the Chinese laborers, who generally constitute half the number employed, receive $1 25 per day. The payroll has amounted to $1,200 a week, a large proportion of which is spent in Oroville; hence, the importance to the town of the success of these works.

OTHER PROPERTIES.

Lying back of the Golden Feather Company's ground is the old Miocene Hydraulic Mine, at present enjoined from work. It is located near Thomson Flat, at the foot of the basaltic table-land known as South Table Mountain, and covers valuable gravel deposits, which crop out under the lava in Morris Ravine. This ravine, which makes down to Feather River near the junction of the flume and canal, has been worked at different times through its entire length, and has paid well; it divides the South Table Mountain from the North Table Mountain. Two large hydraulic mines, the Hendricks and the Wagner, situated in this ravine, are under injunction of the law, but are trying to open out their properties by the drifting method. These basaltic rocks form the banks of the Feather River up to where the North Fork enters, when slates take their place.

Passing up the main Feather River, on the west bank, is the Banner Mine, which is being handled by Col. F. McLaughlin; also the old Brown or Armstrong Mine, which is being developed by its owners, who are driving ahead in their tunnels. The quartz taken out is worked up in a Hinkle crusher and a 10-foot arrastra.

THE GOLDEN BANNER MINE.

This property is situated about 4½ miles from Oroville, on the east side of Table Mountain. The vein shows itself at the head of Gregory Gulch, which proved rich when worked up to where the vein crossed. The vein courses from here 10° east of south toward the Feather River. The property, with the extension, includes 6,000 feet on the vein, with a width of 200 feet. The ground is patented.

On the surface near the present works three veins present themselves, running parallel with one another. The veins are designated, commencing on the west side, the Little Banner, the Big Banner, and the Amoskeag.

The Little Banner is incased in slate with diabase on the foot wall side, called, locally, "conglomerate." Sixty feet to the east is the Big Banner, in slate. Beyond this, 750 feet to the east, is the Amoskeag, in altered slate. Between the last two is a dike of diabase.

The Little Banner is about 18 inches wide and pitches to the northeast. The Big Banner ranges from 2 to 4 feet, pitching to the southwest and coming together with the former at a depth of 200 feet. The Little Banner has a pitch of 7 feet in 100 feet, while the Big Banner pitches 10 feet in the same distance. Most of the former workings of this mine, which has been idle for a number of years, were on the Little Banner, which, down to a depth of 200 feet, has a recorded yield of $600,000. A perpendicular shaft has been sunk 325 feet to the east of

the Big Banner vein, 10 feet 4 inches by 5 feet 8 inches in the clear, timbered throughout with sawed lumber, with two compartments. From this shaft crosscuts have been run at the 200-foot level 45 feet to the Little Banner vein, where the pay shoot was cut, and drifted on north for a distance of 200 feet (all in pay), and 75 feet to the south, but nothing was met with on that side. The pay shoot on the north dips in that direction rather flat. The crosscut on the 300-foot level reached the Little Banner in 38 feet, but did not strike the north pay shoot until 140 feet had been drifted. From there for a farther distance of 110 feet the drift was continued, mostly in pay. Beyond that the vein seems to break up in small feeders that branch out fan-shaped, but presumably come together again, as the vein is found solid on the surface farther north. Where the vein is split up the country rock is softer and appears to be broken up. The slate between the two Banner veins quarters on them and carries with the cleavage small seams of quartz, containing more or less water. These seams, where they terminate against the vein, usually form small pockets of gold. Of the two Banner veins the Little Banner, with her northeast dip, is undoubtedly the principal and true fissure, carrying as she does a distinct gouge for the whole distance explored.

At the 300-foot level a crosscut was likewise run east a distance of 600 feet to the Amoskeag vein, and was carried through the vein into the slate beyond. The formation around this vein resembles greatly the so-called porphyry belt in El Dorado County, though not as thoroughly decomposed as that is. It is mineralized, carrying 2 per cent of sulphurets, and will some day prove a valuable low-grade proposition. For the present this part of the property has been abandoned, and as it furnishes the largest part of the water that has to be pumped from the mine, the connecting crosscut is being bulkheaded.

The plant at the shaft comprises a double reel winding gear, with $\frac{3}{4}$-inch steel rope, cages and water-hoisting tanks, a Rand air compressor to run two machine drills, and an air pump run by a fifty horse-power steam engine.

The rock, hoisted in a self-dumping bucket, discharges into a car run by hand to a breaker, from whence an incline double track conveys the quartz to the mill.

The mill, likewise run by steam, contains ten stamps of 750 pounds, supplied with Tullock feeders; also a 6-foot Huntington roller quartz mill. The battery frame is built for ten additional stamps. Concentrators have not yet been erected, but the power to run them, also the space for erecting them, is prepared.

Beneath the boarding house is a tunnel that will ultimately be continued to cut the shaft, which it will do at about 100 feet vertical. Conveniences for the men and officials, in the shape of boarding houses, sleeping houses, offices, etc., are well and conveniently situated.

As soon as the mine has been a little further exploited it is the purpose of the owners to reduce the cost of production by supplanting steam with electricity, for which purpose a dynamo would be erected on the river three quarters of a mile away, and the power transmitted to the mine. At present use is made of electricity to fire the blasts in sinking the shaft, which is being extended down another 200 feet, when it is expected to find the vein crossing the shaft.

About twenty-nine men are employed at present in and around the

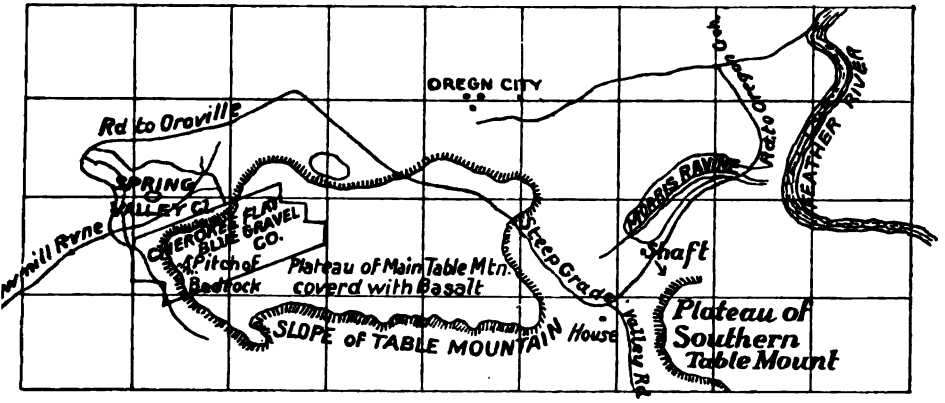
mine. Miners' wages are $2 50 per day; skilled machine drillers, $3. A large force will be put on as soon as the mill is started again, it being at present idle.

DEFIANT MINE—SPRING VALLEY MINE.

About 1 mile above Oregon City to the northeast is the Defiant Mine, also idle at present. The vein courses 80° west of north, with a pitch of 40° to the east, averaging 2 feet in width. The ore is free milling. A double compartment shaft 90 feet deep, with a small upright steam hoist and ⅝-inch wire cable, and a plunger pump, besides a five-stamp steam mill, constitute the plant.

In T. 21 N., R. 4 E., M. D. M., is a large body of quartz, known as the Nisbet ledge, which is being worked in a small way by the owner and his sons. At the foot of the ledge is a small valley containing a body of gravel that pays well to work by the hydraulic process. This whole property is known as the Spring Valley Mine.

All of these properties would well repay the investment of some capital.



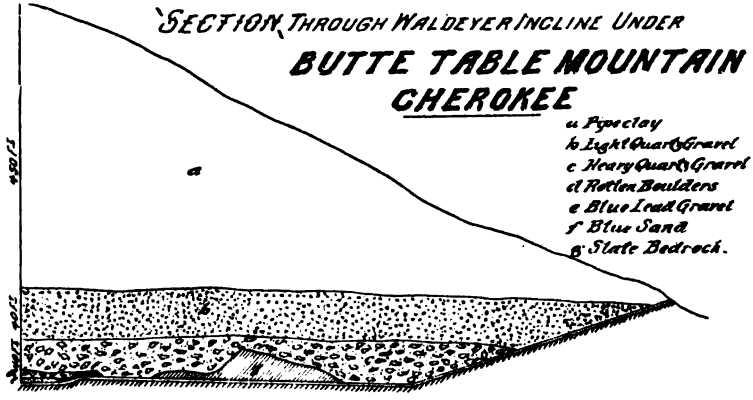
CHEROKEE FLAT GRAVEL MINE.

What was formerly one of the largest hydraulic mines in the State, as well as one of the most productive, is situated due north of Oroville. This is the Cherokee Flat Gravel Mine, and was, when visited, lying idle under the law enjoining the working by the hydraulic process, but active measures are on foot to try and work a part of the property by the drift process. In the meantime, parts of the ground are made to yield several thousand dollars a month by ground sluicing and the use of the rocker and pan.

CHANNEL OF SPRING VALLEY HYDRAULIC MINING COMPANY.

The channel which has been worked by the Spring Valley Hydraulic Company lies at the north end of Table Mountain, pitching with the bedrock, which is largely slate, intersected with dikes of diorite, coursing northeast, and extending partly under the basaltic plateau. It was a break in this gravel, at the head of Morris Ravine, that furnished the

latter with much of the gold for which it was famous in the past. A lava cap covers the channel, in places, from 80 to 100 feet in thickness; also a stratum of pipe clay that attains a depth of from 200 to 300 feet. A section through the channel shows on the bedrock a dark cement, above which is a blue gravel from 10 to 15 feet thick, which carries the greater quantity of gold. Overlaying this and formed apparently by



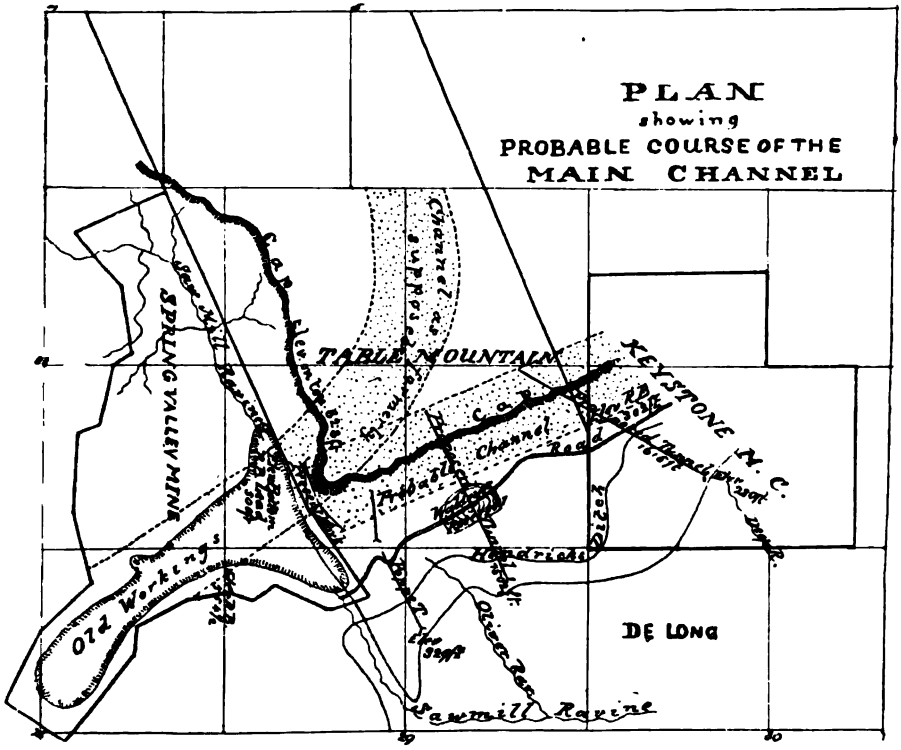
a separate flow, is what is known as the rotten bowlder layer, which yielded from $1 to $8 per cubic yard. The whole is covered with a deposit of fine white quartz sand and gravel, with a capping of pipe-clay several hundred feet deep. The present course of the channel is somewhat in doubt, and is one of the important questions that have to be considered in deciding the possibility of working the claim by means of drifting. Those intimately acquainted with the working of the ground differ in their opinions.

The sketch on page 157 shows the different ideas as to its course. A shaft has been sunk in front of the present bank to a depth of 140 feet, through the bedrock, from whence a tunnel, known as the L. Glass tunnel, has been run 900 feet under the bank. It is argued that if this were carried forward on the present grade of the pay channel, it would strike the level of the same at a farther distance of 800 feet. At the present termination of the tunnel, an upraise was made to the rotten bowlder level, which was drifted on for a distance, until daylight was reached in the face of the bank, having followed the rotten bowlder strata continuously. In connection with the idea of working the mine by drifting, the possibility of running a tunnel from the north side into the mountain was discussed, in furtherance of which the McCann tunnel was projected. Another suggestion was to run a tunnel from the Waldeyer reservoir.

Years ago an incline was sunk in this neighborhood, which demonstrated the presence of the rotten bowlder and blue gravel strata in that locality.

If the Morris Ravine, which lies to the south of this claim, is really fed from a break of the Spring Valley channel, it would prove it to run 1¾ miles beyond the point where it has been worked up to date.

In going from Oroville in the direction of the west branch of the North Fork of Feather River on the stage road, after flanking Table Mountain, and passing through Pentz, where the slates first show themselves, the road traverses Masilla Valley, where a couple of small lime-



kilns are burning limestone from a vein of black marble that extends down the west branch on the right hand side of the river. This limestone incased in the slate can be traced for miles through the country, and is from 10 to 15 feet thick. There are some quartz veins being prospected in the neighborhood of Masilla Valley, with encouraging results.

At Yankee Hill, on the west branch of the North Feather, just north of Cherokee, is a very large vein of quartz coursing 17° east of north, dipping 32°, with a width of 50 feet, showing very bold, heavy croppings. It is known as the Yankee Hill ledge. The surface has been hydraulicked, and has paid extremely well, but for several years no work has been done. Another large ledge not worked at present lies east of the town of Yankee Hill, and has a course 55° east of north, dipping at an angle of 50°.

About one mile from town is a peculiarly formed hill, known as the "Hump," which seems to be the result of a local upheaval. It is traversed in all directions by small quartz veins; the rock itself seems to be a decomposed diabase. Considerable surface prospecting has been done here, but evidently without paying results. On the west side of Yankee Hill there have been rich surface diggings, the gulches having been worked right up to their heads, and are said to have yielded several hundred thousand dollars.

Three miles from here is Jordan Hill, where several promising quartz veins are being opened, notably,

THE RAINBOW AND THE CHRISTY.

These mines are situated 24 miles to the northwest of Oroville, at an altitude of 1,875 feet; they average about 2½ feet in width. The country rock is slate and serpentine. The ores are free-milling gold quartz, with iron sulphurets. The Rainbow has a five-stamp steam mill, with 750-pound stamps, which crush 1¼ tons to the stamp per day. The apron is silver-plated, 5x6 feet, and has a pitch of three fourths of an inch per foot. The quartz from the Christy Mine is said to average about $12 per ton.

Crossing Con Cow Valley and the west branch of Feather River, the spur of the Sierras, known as Dogtown Ridge, is encountered, running north and south, with the west branch of the Feather River on the east and Butte Creek on the west. This is a slate ridge, traversed in part by serpentine, more especially just north of Dogtown, where the serpentine crosses the ridge in a belt half a mile wide, coursing northwest and southeast, and forming on the east bank of the west branch of Feather River a conspicuous peak, just opposite the town, known as Sawmill Peak, 3,200 feet high. About 2 miles above town, on the right hand bank of the river, a tunnel has been driven under the ridge 400 feet, at a point where there is a lava capping 300 feet thick; the direction of the tunnel is about 70° west of north. At a distance of 100 feet from the mouth a 30-foot wide gravel channel, containing coarse gold (ounce pieces), was cut through. The tunnel was continued to reach the main channel that runs under the ridge; the water being handled by a syphon.

Across the river at this point are two adjoining mines, known as

THE WILLARD AND RED HILL MINES.

The river, when running on a higher level than at present, caused a big eddy at and above this point, forming an extensive bench, where extremely large bowlders are found on the bedrock, with considerable coarse gold, some pieces weighing from 5 to 11 pounds avoirdupois. There is a record of one piece having been found on the Willard ground that brought its owner $13,312. These mines are at an altitude of over 2,000 feet, about 2 miles from Magalia or Dogtown, and are reached by trail only. The country rock is clay slate and decomposed serpentine. The vein of the Willard has a northwest course, dipping at 42°, and with an average width of 2 feet. On account of lack of capital the work of opening up this mine proceeds but slowly. In former days the surface has been hydraulicked with paying results. Since then a shaft has been sunk to a depth of 56 feet, and a tunnel run 200 feet, connecting the two mines at the bottom. The prospects are favorable, and the present owners would be glad to get capital interested under favorable conditions, to expedite the work.

A number of other mines, more especially on the right bank of the river going north, are driving tunnels under the lava to open out the gravel channels known to exist under the Dogtown Ridge, and some of them are meeting with good success. The workings of these mines were fully explained in the last report.

Seven miles north of Magalia is the stage station Lovelocks, southwest of which, 1½ miles distant, is Todtown. In the early 70's a five-

stamp quartz mill was operating here on Little Butte Creek. The shaft from whence the ore was obtained was under the mill. Quarrels among the owners caused the property to be shut down, notwithstanding the ore at the time is stated to have been of a fair grade. Everything at present is rotting down.

A couple of miles beyond, John Hupp is opening out a former channel, immediately adjacent to the present creek bed.

A couple of miles to the southwest, where the gravel breaks out from under the lava, is

THE INDIAN SPRINGS DRIFT GRAVEL MINE,

Which has been worked continuously since 1860. The lava capping over the channel is 500 feet in thickness; the gravel deposit in the channel is 6 feet thick on an average; the channel courses southwest and northeast. The elevation of the top of the deposit at the mouth of the tunnel is 2,930 feet; that of the bedrock at the same point 2,400 feet. The tunnel starts in on the slate bedrock, running up stream 4,662 feet, costing to run on an average $6 per foot. It is ventilated by a fan run by water power. The breasts are 120 feet wide and 6 feet deep. The cobbles and bowlders average about 50 per cent. The usual stint for a miner is three carloads of gravel, weighing 1,500 pounds per car, to a shift. The carload of gravel is stated to yield about $7 or $8, the gold being worth $19 per ounce. The work is carried on the whole year; part of the season the water is free, but during the summer months 40 miner's inches is bought from the Cherokee ditch, costing 4 cents per inch. This water is delivered under a 20-foot head. The John Hupp Mine, mentioned above. is supposed to be on this same channel.

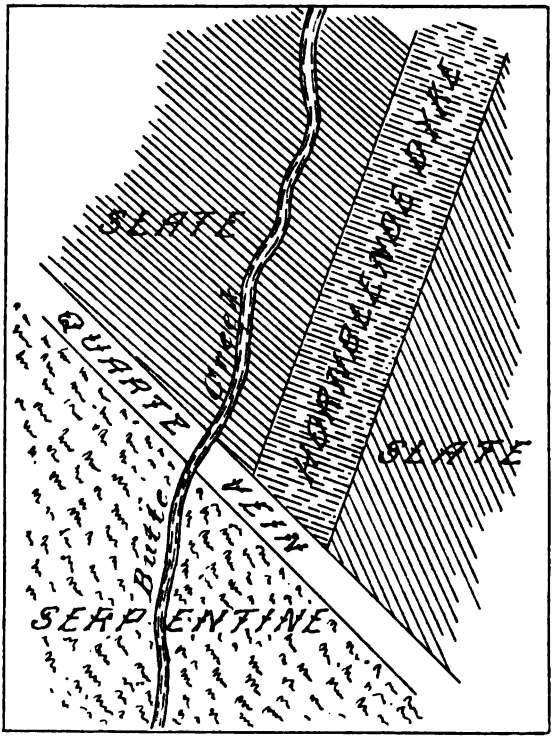
Little Butte Creek, which runs through a good gravel country, heads at Powelton, and, after a 5-mile course, empties into Big Butte Creek. On the east side of Butte Creek all the channels drain themselves, while on the west side they sink. The lava capping is only on the west side of Little Butte Creek until the noted Perschbecker Mine is reached, when the lava crosses. All the older channels in this section of country contain granite wash, which is lacking in the younger channels. No granite in place is found nearer than 20 miles, and that is to the northeast, near the Plumas County line. The older channels, such as the Perschbecker, Indian Springs, etc., are cut through by the newer ones. At the Perschbecker Mine, which was idle at the beginning of the summer, but has since started up and is maintaining its old-time reputation as a gold producer, they have followed the pitch of the bedrock about 200 feet below the present creek channel level, without having reached the bottom, and yet within a distance of 400 feet on both sides the bedrock crops out to the surface. The gold found here is very coarse channel gold.

THE BEST MINE,

Which was thoroughly described in the last report, has worked 200 feet more of their 300-foot channel.

THE WOODS MINE,

Which is also on the east side of Butte Creek, on the Powelton Ridge, has granite and quartz wash, as well as very coarse gold. The rim of the channel next the present Butte Creek is formed by a hard dike, which runs about northeast and southwest, and cuts off the slate next the river from the slate on the opposite side. Changing the dip and course, this dike, as well as the slate, is cut off again by a quartz vein 60 feet wide, on the opposite side of which runs a belt of serpentine, which is the same as that seen above Dogtown.



THE ORO FINO MINE,

Situated in Helltown Mining District, not far from the Indian Springs Mine, on Butte Creek, has drifted through the bedrock 221 feet in a southeasterly course. The channel has been worked a distance of 1,800 feet; it has a steep grade and drains itself. The gravel, which is free, is from 3 to 5 feet in depth, with a lava capping of 600 feet. The pay is mostly on the serpentine bedrock. The channel has a southwest course, while a feeder comes into the main channel from the east. The breast is carried 40 feet wide. The proportion of gravel to bowlders is as 1 to 3. The rim is very steep; in the feeder, in a distance of 225 feet, the raise amounted to 70 feet above the main channel. Above the gravel is a small streak of pipe clay from 6 to 8 inches, then a layer of

fine sand 2 to 3 inches thick, filled with water, and above this again pipe clay. This company own their water during the winter season; the remainder of the year they buy 10 inches of water, at 5 cents per inch, from the Spring Valley ditch; the water is delivered under a 250-foot pressure. They employ eight men—three working on the main channel, three on the feeder, and two cleaning. It was stated they were making $100 to the man. The gold was worth $17 50 per ounce.

On Sec. 3, T. 22 N., R. 3 E., runs a vein of iron ore from 2 to 100 feet wide in the serpentine bedrock, which is said to carry from 5 to 8 per cent of manganese, 60 per cent of iron, and a trace of chrome. In the same neighborhood, between the serpentine and slate, is a bunchy vein of crystalline limestone from 8 to 10 feet in width. Two hundred feet west in the slate are two quartz veins 500 feet apart, having the same course and dip as the slate and measuring from 4 to 10 feet in width. The Carrol Gulch and the Middle Butte Creek both cut through these ledges. Only a little prospecting has been done here, which does not harmonize with the assertion that the quartz assays $12 per ton.

THE PORPHYRY POINT MINE.

Situated on the Little Butte, northeast of the Best Mine, is a peculiar formation. The mine is 3 miles north of Magalia, but the formation extends from here in a southeasterly direction toward the Willard Mine. It lies against the serpentine, is entirely decomposed, resembling a very fine-grained sand and clay, and is traversed with fine seams of quartz and filled with cubical iron pyrites. On washing the material in the pan, some of it gives good gold prospects, the metallic particles being extremely fine. The fine quartz seams likewise contain gold. The ground is worked with sand augers. This formation has a width of over 200 feet. A tunnel 250 feet long has been run, reaching a vertical depth of 50 feet. Four feet a day is made in drifting; no stoping has been done. The pay shoot has been traced for 500 feet. A circular shaft 50 feet in depth has been sunk, all in the same material. Hitherto the owners, not having any mill, have run the material through a long ground sluice 200 feet, and then through sluices without any quicksilver, the quartz going over the dump. A large amount of sulphurets is obtained—the owners claim 3 per cent—which assay from 5 to 11 ounces of gold per ton. The mine is worked by the three owners; in their operations they use 100 inches of free water during the season, which is generally from December to the last of May. Outside of the tunnel is a cut run in a distance of 100 feet.

THE PERRY MINE

Has been fully described in the last report, and is situated on the Little West Branch of the Feather River. The incline tunnel has been advanced 500 feet during the past year, without, however, tapping the old back channel that courses north of northeast, and which connects with the Dogtown channel southwest of Magalia.

THE BADGER CLAIM.

Near the latter the owners of this claim are running a bedrock tunnel, with the intention of striking the channel. They have driven in 700 feet, and expect to run 100 feet more before breaking into the channel. The road that connects upper and lower Magalia cuts through the lava capping of the channel, which crosses the west branch above town, in the neighborhood of the Willard Mine.

Starting from Oroville to the east, on the Forbestown road, at the junction with the Miners Gulch road, the slates and metamorphic rocks give place to granite, which continues until the Forbestown Ridge is reached. The granite extends down to the Honcut. The Forbestown Ridge skirts along the South Fork of the Feather River, and contains a number of large quartz veins. Those that are being developed are the Gold Bank, the Golden Queen, and the Shakespeare.

THE GOLD BANK MINE

Has, during the past year, remodeled its reduction works. After a thorough trial with rotary mills, the owners rejected them and put in their place a modern equipped twenty-stamp mill, run, as is the rest of the machinery, by water power operating through hurdy-gurdy wheels. This property has been very thoroughly described in previous reports. During the past season the shaft has been continued to a depth of 365 feet, and a third level started at the bottom of the shaft with drifts running 150 feet to the west and 60 feet to the east, besides cross-cutting west 35 feet. After considerable experimenting, the management has succeeded in successfully chlorinating their sulphurets, of which they have a large percentage. They have brought the result up to 95 per cent of the assay value. They employ, when full handed, fifty men.

THE GOLDEN QUEEN MINE.

The ledge this company is working on lies very flat; it courses northeast and southwest, dipping to the north about 20°, and presents some peculiar features, which have been taken intelligent advantage of by the management, in their methods of opening it out. Occasional pillars of quartz are left between the blocks excavated, and the stopes, as far as possible, filled in with waste quartz solidly, after thorough timbering. All the gangways on the vein are very substantially timbered. The walls are greenstone, decomposed next to both walls, that on the hanging wall side being the most changed. Both walls are extremely smooth and regular, with the exception of one place, where there is a uniform break of about 3 feet in the foot wall, extending in the direction of the strike. The quartz is streaked with sulphurets, mostly iron, although tellurides and some little galena are occasionally found. Quartz that shows no sulphurets is hand-sorted in the mine and used for filling to support the roof. In free gold the ore may contain in the neighborhood of $5, but the 1½ per cent of sulphurets in the ore, which are very closely saved, reach into the hundred dollars per ton. The vein averages 20 feet in width. Considerable attention has been paid to supplying the mine with air, an intelligent system of ventilation bringing a sufficient

amount of air to every part of the mine. A water blast is furnished, run by a 6-foot overshot wheel, to be used in case of emergency.

The ten-stamp mill, worked by water power, is supplied with a No. 2 Gates crusher, capable of handling 200 tons a day. The crushed ore passes to the Hendy self-feeders. The crusher is worked by a separate Pelton wheel 3 feet in diameter, the waste water from which is used in the batteries. The stamps weigh 750 pounds and make ninety drops of 4½ inches per minute, crushing 3 tons in twenty-four hours. The shoes are steel, working on iron dies. The silver-plated aprons are only about 1½ feet long, and are cleaned up but once a week. The pulp, after leaving the apron, passes over a 16-foot sluice plate 16 inches wide onto blankets; then through a course of sluices, supplied with occasional cross slats. This treatment takes out the coarser pulp, which is shoveled onto a platform and worked through a 16-foot buddle. The remainder of the tailings is treated on a canvas plant, which is said to be very efficient. In treating the tailings by this method the principle of sizing the pulp, which is of so much importance in a proper concentration, has been given careful attention. The canvas plant consists of an inclined platform 20 by 48 feet, over which canvas is tightly stretched, and the whole divided by slats into widths to represent sluices. At the upper end of the platform are two sluices, placed one above the other, running the whole length; one contains the tailings as they come from the sluices with the cross slats; the other contains clean water. At the end of the platform, slightly lower, runs another sluice, in which the concentrates are swept. Each of the upper sluices is provided with a half to three quarters inch plughole over every partition of the canvas platform. In operating, both plugholes are opened, and the diluted pulp allowed to pass over the canvas until it is coated with fine particles of sulphurets, amalgam, etc. The plug is then inserted in the sluice containing the tailings, while the clear water continues to flow until most of the sand deposited has been washed off, which, with a little practice, can easily be distinguished. The canvas is then swept off with a common broom, the sweepings being conveyed into the sluice at the lower end of the platform. These canvas gleanings are said to equal in value the blanket and buddle concentrates combined. The concentrates have been shipped in three classes, but it is the intention of the owners to erect a plant of their own for beneficiating their sulphurets in the near future.

These two mines are situated on opposite sides of Slaughter House Ravine, which runs from the town of Forbestown, a distance of 1½ miles down to the South Fork of the Feather.

EMMA MINE—SHAKESPEARE MINE—OTHER PROMISING MINES.

One and a half miles below the mouth of the cañon, on the river, is the Emma Mine, working on a large quartz vein that crosses the river at that point; said to contain rich sulphurets. From Indian Gulch, 3 miles northwest of the South Fork, the granite divide runs across to, and over the river. Above Hartman's Bar, a limestone belt about 10 feet wide crosses to the Middle Fork of the Feather.

On the south side of the Forbestown Ridge, back of the town, is the Shakespeare Mine, the oldest of the quartz mines of the neighborhood that are being worked. It has been bonded to parties who are now putting down a double compartment shaft, on a vein that is from 6 to 10

feet wide. The shaft has already attained a depth of over 300 feet. A ten-stamp mill reduces the ore. As necessity requires, the mill will be enlarged. It is believed that ultimately electricity will be used here as the motive power.

Some of the other promising mines along the ridge are the Sagamore, the Ground Hog (a pocket ledge), the Bazoo, and the Dutchman. But little work is being done on them at present.

Starting from Oroville northeast a noted mining camp of early days is reached at Bidwell's Bar. The road to it turns off at Miner's ranch to the north, through several miles of a slate country. In approaching the bar from this direction, the configuration of the country would lead to the idea that at some former period the river, or one of its tributaries, had flowed through the cañon in which the road now leads down to the bridge on the bar. The altitude on the bridge by aneroid reading is 330 feet. After crossing to the opposite bank, the road gradually rises to an altitude of 4,750 feet at the summit. Near to Hart's Mills, the road crosses the granite belt that ranges over into Granite Basin, across the Plumas County line, a width of 10 miles, with but a single intermission of slate. This granite varies in quality from a coarse-grained, easily decomposing granite, to a syenitic granite, with dikes of diorite, in which latter material the American Eagle vein is found.

THE AMERICAN EAGLE MINE.

This vein, which is situated 4½ miles west of Merrimac, in the Peavine District, presents a large mass of low-grade quartz, with a casing of chloritic schist, and very smooth, regular walls, adjoining which the quartz is of a sugary nature, carrying ochery streaks, that prospect better than the surrounding rocks. The chief value of the ore is found in the sulphurets, which it is stated assay up to $250 per ton.

The mill, which is supplied with two Triumph concentrators, one of which has a double belt, is to receive an additional concentrator. A fine water power, under 300-foot pressure, provides sufficient power for all purposes. Only a small force of men were at work during the early summer.

THE PALO ALTO MINE.

A mile and a half from this mine is the Palo Alto Mine, owned mostly by San José parties. This property is being developed in a systematic way, and has the assurance of success. The ore is a ribboned quartz, carrying sulphides of iron, lead, zinc, etc., and is reputed to assay from $200 to $1,000 per ton. Additional stamps are being added as the mine is being developed, to permit the taking out of larger amounts of quartz.

OREGON, BLOOMINGDALE, AND CAMBRIA MINES.

These mines are situated about 9 miles northeast from Oroville. They have been incorporated under the name of the Standard Gold Mining Company, and are being actively developed.

At Bangor, about 15 miles southeast from Oroville, two new gravel mines have been opened on the old blue lead, with very promising results.

There is hardly a part of the north and eastern portions of this county but might be turned into prosperous mining camps. The amount of undeveloped ledges, which, under the present improved methods of working, would pay good interest on invested capital with proper business methods, is astonishing. But it requires capital. Already some of the most enterprising and successful mining men of the country are beginning to take hold and develop the hidden wealth of Butte, and if it were not that so much of the mineral lands had passed into private hands under the present interpretation of the laws, a good deal of prospecting would be done. Not only quartz ledges are awaiting development; equally numerous are the old water channels of former periods, buried beneath their blankets of lava, that can be drifted after and made to surrender the wealth they contain.

THE VALLEY LANDS OF BUTTE COUNTY.

By W. L. Watts, Assistant in the Field.

WATER SUPPLY.

The town of Chico is supplied with water by the Chico Water Company, which obtains its supply from wells of large diameters connected by drifts penetrating a bed of gravel underlying the town. There are two pumping stations belonging to this company; an upper one, situated in the northeastern, and a lower one, in the northwestern outskirts of the town. At the lower station there are two wells, one 6 feet and the other 3 feet in diameter, both being about 35 feet deep. These wells are connected at the bottom by a tunnel. From the bottom of the larger well three tunnels extend some 35 feet into the gravel yielding the water supply. During the winter the water rises nearly to the level of the top of the gravel stratum, which is about 10 feet below the surface of the ground; and during the summer it never sinks lower than about 15 feet below the top of the gravel. The upper pumping station has a well of equal depth, but of larger diameter, and the tunnels at the bottom extend farther into the gravel. This is the principal station, and it can furnish water at the rate of about 1,500,000 gallons in twenty-four hours, while the lower station has a capacity of about 1,000,000 gallons. It is the opinion of the manager that more than a million gallons of water could be pumped every twenty-four hours without exhausting the supply.

In and around Chico a 6-inch well bored to a depth of from 16 to 22 feet will furnish plenty of water for a No. 6 Douglas pump. The formation, as shown by borings in and around Chico, appears to be as follows:

Black loam	4 to 6 feet.
Yellow clay	10 to 12 feet.
Gravel, with water	4 to 10 feet.
Clay	3 to 10 feet.

Beneath the clay is gravel, with more water, which rises to the level of the surface water. In some instances a stratum of lava has been encountered at a depth of about 20 feet.

From 1 to 6 miles north of Chico the surface soil averages from 10 to 17 feet in thickness; this overlies a stratum of yellow clay from 6 to 10

feet thick, beneath which is cement, passing into gravel with water. Toward the northern edge of the county much cement is encountered in boring.

Along the bank of the Sacramento River a sandy sediment soil extends to a depth of from 12 to 15 feet, and beneath this is clay to a depth of 90 feet. Water is obtained beneath the sediment soil and also from small strata of sand and gravel in the clay. Most of the wells along the river are from 25 to 40 feet deep.

Southeast from Chico the formation resembles that observed to the north of the town, and the water-bearing strata lie at an equal depth.

Toward the foothills water is scarcer and a tufa lies quite close to the surface; the soil is gravelly, and in many places full of large pebbles. The tufa has in some places been penetrated to a depth of 95 feet without obtaining water. The thickness of the tufa is demonstrated in the creeks flowing from the foothills; a remarkably good exposure occurs in what is known as Wild Way, on the estate of General Bidwell. Most of the wells in the vicinity of the foothills are dug, and a small supply of water is usually obtained at a depth of about 80 feet.

In the vicinity of the railroad, between Chico and the Yuba County line, an abundant supply of surface water can be obtained at a depth of from 10 to 12 feet, but wells are usually bored to the depth of from 20 to 35 feet to the second stratum of gravel, which contains plenty of excellent water. The writer could not learn of any flowing wells in Butte County.

COAL.

Coal was mined at an early day near Oroville, on the property of C. F. Lott; a tunnel being run in for about 35 feet and the vein drifted on, for, it is said, several hundred feet. The vein is reported to have been about 6 feet thick. This coal was used during the 70's at Oroville, both for fuel and for making gas. It is said to have burned well, and the gas made from it to have been of good quality.

A few yards from the tunnel, and at a slightly lower elevation, a boring was made to the depth of about 25 feet. The formation was bluish clay, which is said to have yielded gas in the retorts. At a depth of 25 feet, a bright looking coal was struck, which burned well; but this coal stratum was not bored through. The mouth of the old workings is now caved in, but in the creek on which the workings are situated, a bluish clay is exposed. An arenaceous stratum overlies the clay.

Higher up the creek a light-colored shale, showing plant remains, is exposed, passing into a light-colored, sandy clay, which in some places cements together numerous white quartz pebbles.

Down the creek from the old workings the formation is a light-colored, friable sandstone, in places much stained with oxide of iron. The coal-bearing formation evidently underlies the lava forming the mesa above.

CALAVERAS COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

This county has the advantage of direct communication with trade centers by means of railroads extending into it at two points, Valley Springs on the north and Milton farther south. Like the neighboring counties both north and south, its principal mining interests center around the Mother Lode belt, which enters the county from the south at Robinson's Ferry, on the Stanislaus River, and leaves it in the neighborhood of Poor Man's Gulch, on the Cosumnes River.

The developments on the copper belt in the metamorphic slates to the west of the gold belt are quite a feature of the mining interests of the county, and show what may be looked for in the future, when the price of this metal stands in better relation to its cost of production.

In visiting Copperopolis, where extensive copper mines and reduction works are located, the road from the south, crossing Reynolds' Ferry over the Stanislaus, was traveled. Entering the county at the Bear Mountain range, which in its northerly trend separates the gold-bearing slates around Angels Camp from the copper-bearing ones of Copperopolis and Campo Seco, the road from the river bank climbs up and across this range, and up Black Creek to the depression running parallel with the mountain range in which the mine and town of Copperopolis are situated.

The belt of slates, running northwest and southeast, that forms the country rock lies from 8 to 12 miles west of the Mother Lode proper, dipping almost vertical and showing a distinct iron head, by which the copper-bearing strata can be distinctly traced, which is found to contain pure sulphide ores, often in large, solid masses. Following it up north, it curves out to the west, where it is bounded by serpentine, north and west of which another small gold-bearing belt is found, which rather upsets the theory sometimes expressed that there are no paying gold-bearing veins west of the Mother Lode belt.

One peculiarity of these copper ores around Copperopolis, is the fact that they contain neither gold nor silver in their make-up, while farther north, at the Campo Seco Mines, where the copper belt and the gold belt approach one another much closer, the ores contain both. Along the croppings some carbonate ore, also red oxide, and even native copper in small quantities, are occasionally found, but the main masses are sulphides. A series of shafts has been sunk along the course of the croppings, varying in depth from 65 to 200 feet. Two of these, with their hoisting works, have been burned out during the past years, greatly retarding the work. They are being reopened with a very fine steam hoisting plant.

The ores, after being raised, are hand sorted, the better portion being run on a car track direct to the furnace, where matte or black metal is produced and shipped to Boston, Mass. The poorer ores are piled in large heaps and roasted in the open air and leached. Two thousand

tons are at present in these piles. The saturated leach waters are conveyed to tanks, from which they are charged into a large revolving drum, holding 16,000 gallons at a charge, making about six revolutions a minute. With the liquor a certain amount of scrap sheet-iron is charged; this scrap is obtained in San Francisco and laid down at the works for about $20 per ton. The drum is supplied with automatic acting valves in the end, to allow of the escape of the hydrogen gas formed. After a sufficient length of time, which depends on the degree of saturation of the copper solution, the manholes of the drum are opened and the mass discharged through wire screens placed over them into tanks immediately below, the scrap iron being detained on the screens. From the tanks, the cement copper that had formed in the drum, after settling, is shoveled onto heated drying floors and stirred till the moisture is evaporated, when it is sacked and shipped, to be used for paint. The sacks are double for this purpose, the inner sack being made of brown muslin. The matte is passed through a Dodge crusher before being sacked.

Two and a half miles southwest from Copperopolis, after crossing an extensive belt of serpentine, flanked by metamorphic slate, a small group of gold mines is reached. The principal one is known as

THE PINE LOG MINE.

The Royal Consolidated Gold Mining Company, which operates this mine, is working on an 8-foot vein in slate bedrock, striking east of north and dipping 45° to the southeast. The company controls three full claims. The work is being prosecuted on a shoot of ore pitching to the north, the extent of which has not yet been determined. The work is carried on through a shaft 150 feet deep and a tunnel that crosscuts the formation for 100 feet, till it cuts the vein, along which it is continued a further distance of 150 feet, reaching a vertical depth of 80 feet below the surface. The timber is brought from a distance of 8 miles, and costs $18 per thousand. The quartz is free milling, carrying from 1 to 3 per cent of iron sulphurets; the gold is of a low quality, $13 per ounce. The mill is about half a mile from the mine and contains ten stamps, weighing 750 pounds to the stamp, and dropping 6 inches ninety times a minute, crushing 1½ tons to the stamp through a No. 8 diagonal slot-punched Russian iron screen. The aprons are 4 feet 4 inches by 2 feet 6 inches, with a pitch of 2 inches to the foot, followed by a double length of 12-foot sluices carrying silvered plates 2 feet wide. Besides these the battery is supplied on the inside with an 8-inch plate both back and front. The proportion of amalgam saved in the battery is 60 per cent, on the plates 40 per cent. From the sluices the pulp passes over two Frue vanners, the concentrates from which are shipped to the Selby Works in San Francisco.

The power is supplied by a fifty horse-power engine for the mill—power enough to permit of an addition of ten more stamps as soon as the development in the mine shall warrant the increase. The hoisting works are run by a fifteen horse-power engine, the water supply being taken from Black Creek, in the vicinity. Three cords of wood, partly oak and partly pine, are consumed for steam purposes, costing $3 50 per cord. The working crew consists of eight miners, five men in the mill, and two on the outside—fifteen men in all—who receive $2 50 per day for work in the mine or mill and $2 to outside men.

Returning to the Stanislaus River, and following it up to Robinson's Ferry, the Mother Lode is seen to cross here, and shows itself on the Calaveras side in several veins, that form prominent outcrops on Carson Hill, where they close together, towering about 200 feet above the ferry. The vein crops out between Indian Creek on the southwest and Squirrel Creek on the east side, at their junction with the Stanislaus River. Proceeding along the line of the lode to the northwest the vein crosses Indian Creek, and farther on Carson Creek. The country rock to the south and west of the lode and on the river is a gray slate, penetrated by several dikes cutting across the formation. On the northeast side of the lode, near the Adelaide Mine, is a deposit of steatite (soapstone), which was also encountered in the workings of the Melones Mine, north of the Adelaide, at a depth of about 200 feet, where it fills the entire space between the walls. Between the Calaveras Company's vein on the west and the Adelaide on the east lies a strip of black slate.

THE ADELAIDE MINE.

This is the first active mine after crossing the river. It is working on a vein to the east of the main fissure, with a strike about north 30° west, and dipping east, with an average width of 14 feet between the walls; to the east of the vein is chloritic schist. The real foot wall has not been reached. Three bodies of quartz are found—one on each wall, and a center one; between the quartz are talc seams, carrying large quantities of graphite. On the hanging wall side mariposite and magnesite are found. The largest amount of pay ore has been mined in the central body of quartz, where much of the gold has been spread on the face of the rock, showing that a sliding movement in the vein has taken place. A felsitic dike shows itself in parts of the mine. The quartz is of the ribbon variety, carrying a large amount of sulphurets; occasionally tellurides are found.

The mine is opened by a vertical shaft 95 feet deep, 5 feet by 8 feet, sunk on the vein. On the 50-foot level a drift has been run to the south 70 feet, with two crosscuts—one east, the other west—but the true foot wall has not been reached. At the 80-foot level 60 feet have been drifted to the south. An upraise 5 feet by 7 feet connects the two levels, between which some stoping has been done. The hoisting through the shaft is performed by the aid of a 30-foot overshot waterwheel placed near the collar of the shaft, the water for which is taken from Coyote Creek. Three men are employed in the mine at present. Up to date no reduction works have been erected; only the richest of the ore has been extracted, which has been crushed in a hand mortar.

THE CALAVERAS CONSOLIDATED GOLD MINING COMPANY (LIMITED).

This company's ground, cornering on the Adelaide property on the west, is on the main vein, and comprises several claims. The company intended originally to place their works down near the river, and acquired a mill site near the ferry, and drove a big double-track tunnel 50 feet above the river in the foot wall slate, crosscutting at intervals into the vein, which showed a large body of quartz, dipping nearly vertical. This tunnel would cut the vein several hundred feet below the collar of the present main working shaft. The course of the tunnel,

which is 1,400 feet in length, was with the formation, north 65° west. The mouth of the tunnel is faced in masonry and timbered for some distance for an elliptical tunnel section, using heavy sawed timbers; farther in the width of the tunnel was contracted, and given the ordinary tunnel timber sets. The tunnel was driven with air compressor and machine drills.

Finding that the ore shoots at the north end of the claim carried a much higher grade of ore, the works were transferred to that point. They consist of two shafts—one perpendicular, which is the main working shaft, 200 feet deep, and an incline 80 feet deep. The main shaft is supplied with hoisting gear and a safety cage run by a 3-foot Pelton wheel, and furnished with an electric pump and an electric light plant run by a separate small Pelton wheel, which furnishes the mill and the underground stations with light. Drifts have been run at the 100-foot and 200-foot levels. On the 100-foot level, north 325 feet and south 100 feet; on the 200-foot level, north 150 feet and south 60 feet. From the 100-foot level the ground has been stoped out, and it is from these stopes mainly that the ore for the mill is supplied at present.

The reduction works consist of a twenty-stamp mill with 850-pound stamps dropping one hundred times per minute on a 5-inch drop, and a 7-inch discharge, using No. 40 perforated tinned sheet-iron screens. These screens have to be lightly burned before being used. The preference for this kind of screen is in their more free discharge and cheapness, notwithstanding their short life. The pulp on leaving the battery passes over a short apron about 4 feet wide by 1 foot long; then over double rows of sluice plates, each 2 feet wide by 12 feet long. Two Tullock concentrators take the pulp from two of the batteries, while three Triumph concentrators dispose of the pulp of the other two. The two former are said to do the work as efficiently as the three latter. After leaving the concentrators all the pulp passes over a canvas platform. The batteries are also furnished with Hendy self-feeders, which take the ore from an improved Blake crusher.

The mill is run by a 3-foot Pelton wheel, receiving the water under a 300-foot pressure. In all there are at the works five waterwheels—four Pelton and one Dodds wheel. All except the mill wheel take the water under a 250-foot pressure. This water supply, as also that for the batteries, is taken from Coyote Creek, at a cost of 15 cents per inch. having been previously used for mining purposes. It reaches the works carrying a large percentage of clayey sediment, which is quite a drawback.

The force of men employed at present comprises thirteen miners, four mill men, and eighteen on the outside—thirty-five in all—whose wages vary from $2 50 to $3.

The ore contains about 1 per cent of sulphurets, iron, lead, also azurite and tellurides. The gold is about .780 fine.

VARIOUS MINES.

Continuing up the lode to where the different branches come in together with a general swing toward the east, a small body of serpentine is found. Numerous claims are crowded together in this section; more than twenty are recorded from the river up, some of them with big records as gold producers. None of them have been worked to any great depth, but,

for various reasons, they are at present idle. This is the condition at Carson Hill and Chaparral Hill. The vein, showing itself apparently in one branch only, continues to Albany Flat, where it widens out again, and for a distance of half a mile in width going north the east side is filled with quartz feeders and seams. Through this entire stretch, the slates forming the west wall of the main fissure course parallel with the vein, while the slates on the east quarter on the course of the vein. Just before reaching Angels Camp a narrow strip of serpentine extends for nearly a mile along the east side of the vein.

The large mines in and around Angels Camp, as the Utica, the Stickles, Lane and Tullock, etc., have been repeatedly and thoroughly reported on. They are running steadily. One feature particularly noticeable about these mines is the gathering together of the works, so that the handling of the ores is reduced to a minimum. Another noticeable feature is the amount of attention paid to obtaining the utmost value from the tailings, consistent with economy. As an indication of the prosperity of these works is the contemplated erection of new chlorination works in addition to those already operating, and an addition to the crushing capacity of the Stickles Mine.

North of town and west of Altaville, a suburb of Angels Camp, on the course of the main lode, are the Prince and White Oak Mines.

PRINCE MINE.

The Prince Mine controls two full claims. The country rock is slate and altered schists. The quartz is in places from 15 to 20 feet wide, with a northeasterly pitch. The mine has a main working shaft 140 feet deep and a twenty-stamp mill. The property has lately been bonded, and is idle at present, awaiting the action of the bondholders.

To the west and south of this mine, on a parallel vein, belonging to the Mother Lode system, some claims are being prospected; among them are the following:

ECLIPSE MINE

This mine is situated about half a mile west of Altaville, and is supposed to be on the east vein, controlling 650 feet on the line of the same; the walls are slate. The mine is opened by a shaft 115 feet deep, on which they are still sinking. The hoisting engine is twelve horse-power, which is also used to run a small prospecting mill situated at the back of the hoisting works, containing a 3½-foot Huntington roller mill, Dodge rock-breaker, Hendy Challenge feeder, and a Tullock concentrator. They employ ten men. The mine makes about 500 gallons of water an hour. The main vein is to the east of the present shaft and courses 65° west of north, with a dip of 70° to the east.

GOLD HILL MINING COMPANY

The claim holds 1,460 feet of ground on the vein, and adjoins the Eclipse Mine on the north. The workings extend into one of the low hills that mark the course of the ledge through this section of country. The tunnel is 750 feet long on the course of the vein, obtaining a vertical depth of 75 feet. It is the intention to sink a shaft from the surface down 200 feet, that shall cross the ledge at the 100-foot level. The vein

strikes 45° west of north, pitching to the east. At present the quartz is obtained from an upraise in vein matter above the tunnel, which is seamed full of quartz stringers, the width of the ore body being about 28 feet. The ore is run direct to the mill, which is a ten-stamp water mill with 850-pound stamps, dropping seventy-five times a minute on a 6-inch drop. The discharge is 10 inches, through a No. 40 perforated sheet-iron screen that has an inclination of about 2 inches. The silvered apron plate, 4 feet 2 inches in width, has a length of 10 feet, and a pitch of 1¾ inches to the foot. The stamps crush 2 tons per stamp in twenty-four hours. The mill is supplied with Huntington rock-breaker, Hendy. Challenge, and Tullock feeders, and two Tullock concentrators. The water power is obtained from the Union Ditch Company, 50 inches, at a cost of 10 cents per inch, operating under 150 feet head on a 4-foot Pelton wheel. Thirteen men are employed.

THE BLAIR CONSOLIDATED MINING COMPANY.

In Smith's Flat, about 2 miles west of Altaville, the company controls 2,134 feet by 600 feet, and have applied for a patent; the vein has a northwest course, dipping at an angle of 45° to the east. Forty feet of the vein has been crosscut without reaching the hanging wall. An open cut has been run across the vein 40 feet, and a shaft started on that level 4x6 feet, now down 12 feet between slate walls. The present company has only been at work about one month. The vein appears to be an east feeder to the main fissure. The quartz and sulphurets are high grade. In the face of the drift the rock is said to pay $43 in free gold. The arsenical and iron pyrites are rated at $1,622 per ton; thirty-five pounds of these concentrates are obtained from each ton of ore. Six men are working in the mine at present. The owners contemplate the early erection of a twenty-stamp mill. The mine has a recorded yield of $60,000.

OSBORNE & BRADLEY MINE.

This is the northwest extension of the last mentioned mine, with similar formation throughout. A tunnel 100 feet long constitutes the development, with two arrastras, 8 feet in diameter. Arrangements for a five-stamp mill are being made. Two men are at work.

THE SAFE DEPOSIT MINE

Contains 800 feet by 600 feet, and lies west of the preceding property. There are two tunnels on the property; one, a drain tunnel, is about 85 feet in length, and reaches a vertical depth of 40 feet, crosscutting to the first pay vein, which is 6 feet wide. This will be continued till the hanging wall is reached. The country rock is slate. The second tunnel is about 100 feet long on the vein, which has been stoped out to the surface. A small five-stamp mill, with 650-pound stamps run by a 10-foot hurdy-gurdy wheel, taking water from Union ditch, under 90-foot pressure, is on the property. At present it is in litigation.

YELLOWSTONE MINE—GOLD HILL MINE.

On the Yellowstone, adjoining, several shafts, 30 to 40 feet deep, have been sunk on the vein, showing on the hanging wall side tellurides (petzite). These are on the belt that leads to the Gwin Mine, on the westerly branch of the Mother Lode, the Gold Hill being on the central part. This mine, which has only recently been opened, is temporarily shut down in the settlement of an estate.

TURNER MINE.

This mine has two full claims situated in Greenhorn Gulch, 1½ miles west from Angels Camp. The vein strikes northwest, with easterly dip, and is about 25 feet wide. An incline shaft, 6x6 feet, has been sunk on the vein to a depth of 50 feet. It was located in 1890. The quartz carries about 2 per cent of sulphurets with free gold, which yielded by chlorination $94 per ton; assays made since have shown some results as high as $1,300 per ton. The walls are black slate, well charged with sulphurets near the vein, and occasionally showing free gold on the face of the slate. A second and larger vein, about 80 feet to the east, runs parallel with the other, but does not appear to carry much gold; it has a width of about 60 feet. Between the two veins is a dioritic dike. The hoisting is done by hand at present. A small two-stamp prospect mill, with 200-pound stamps, is in the immediate vicinity of the shaft. It is run with 5 inches of water from the Union ditch, under a head of 150 feet, delivered on a 2½-foot Knight wheel. The stamps fall one hundred and ten times a minute, with a 5½-inch drop. Fifty per cent of the amalgam is caught in the battery; the gold after retorting is .960 fine.

South from here is the Cloud Mine, on the same belt, containing highly sulphuretted ores; arsenical pyrites are also found. A shaft has been sunk 50 feet on the vein, but neither wall is exposed.

THE JONES MINE.

Southeast of all of these, on Carson Creek, near where it empties into the Stanislaus River, about 1½ miles, is the Jones Mine. The mine proper, or older part of the property, was at the time when visited filled with water. It comprised a shaft 120 feet deep, with several drifts and crosscuts, on which hoisting works were being erected. Near by, in the very narrow cañon, while grading out for a forty-stamp mill to be erected, a very strong vein was uncovered and cut into, apparently about 40 feet wide, with free-milling ore, carrying from 2 to 2½ per cent sulphurets, and about $5 to $8 per ton in free gold. The sulphurets and concentrates from the original works assayed as high as $300 to $400 per ton, some choice parcels reaching $1,200.

The newly discovered vein is parallel to the original on the foot wall side and about 250 feet apart. By running a tunnel on the vein at the mill level a vertical depth of from 500 to 600 feet may be counted on. The forty-stamp mill will be in running order in sixty days, as per contract; a compressor plant is also being erected. Several miles of good graded road have been lately constructed to reach the property, also a ditch 9 miles long, which brings the water from Angels Creek, taking it

below the Lane and Tullock mill, to be used as motive power. Thirty men are employed at present.

BRUNER MINE.

This is southeast of Angels Camp about 2 miles, directly in the strike of the Morgan and Reserve Mines on Carson Hill, to the east of the main fissure, about 130 feet higher than Angels Camp. It is supplied with a steam hoist, single reel, hoisting out of a 300-foot incline shaft. The vein is incased in slate. The quartz is honey-combed, rotten, in connection with mariposite, talcose schist, also black metallic slate. Not at work.

TOM HARDY MINE—BALD HILL MINE.

North of this is the Tom Hardy Mine, and beyond that Mr. Graham has worked in a desultory way on what is known as the Bald Hill Mine.

CLOUD MINE.

Due west from the last, at Albany Flats, is the Cloud Mine, in a trough-like depression running northwest. It contains 1,400 feet on the line of the lode. A vertical shaft has been sunk 50 feet deep in the slate west of the vein, which pitches 75° to the east and is from 8 to 12 feet wide, giving by mill process $30 in free gold and $300 in sulphurets. The quartz also contains arsenical pyrites. East from this vein about 150 feet runs a parallel vein that has not been prospected. Eight hundred feet north of the shaft is an open cut that yielded so-called black metal, a very rich ore in which the gold is black. The country is gray slate, some of it highly silicious. The altitude of this mine is 70 feet higher than Angels Camp.

LINDSAY MINE.

Again west of here, several small prospects are found, among them the Antone, or Black Gouge, also called the Lindsay Mine. This property is situated about three quarters of a mile due west of town and west of the Gold Cliff Mine. It consists of 1,885 feet on the line of the vein by 600 feet in width.

The developments comprise an incline shaft on the vein, which courses 75° west of north, pitching with the black slate foot wall for a distance of 80 feet at an angle of 50°; beyond it straightens with the wall to 80°; the hanging wall at the surface is a dike formation. On the east end a tunnel has been driven 90 feet through the slate to the vein. Near the center of the claim a vertical shaft 3½ feet by 6 feet has been sunk to a depth of 120 feet and timbered throughout. At a depth of 112 feet, levels have been driven northwest and southeast, the former a distance of 125 feet, the latter 60 feet. On the northwest side, 60 feet from the shaft, an upraise reaches to the surface, but no stoping has been done. On the croppings all the surface up to the shaft has paid to crush with a hand mortar.

North of the mine lies the McTippican claim; south is the Stickles and the Gold Cliff Mines.

EXCELSIOR MINE.

This mine is on the east side and parallel with the Gold Cliff Mine, and has a vein 14 feet in width, carrying a large percentage of sulphurets. A tunnel has been run in the vein, but neither wall has been crosscut. If continued, the tunnel will strike a shaft sunk 50 feet on the quartz. The claim has only recently been opened and is being worked with four men.

About 5 miles to the east of Angels Camp the limestone belt that crosses the Stanislaus River in the south is split up into several branches, reaching over a width of 4 miles. East of the limestone is a stretch of 3 or 4 miles of dioritic granite, changing beyond to gneiss, followed by regular granite.

SHEEP RANCH MINE.

In this belt is the Sheep Ranch Mine, which has been previously fully reported on. Since that report the following developments have been made: They have carried their main shaft down from the 1000-foot level to the 1200-foot, and have stoped from the 1100-foot upward. The vein, which down to the 1100-foot level held a uniform pitch of 1 foot in 30 feet, is straightening up at the 1200-foot, and as a consequence the vein is in a broken condition. The shaft is sunk in gneiss, and the drifts crosscut behind the shaft to the vein, which is incased in a black magnesian slate, highly metalliferous. The vein averages from 1 to 2 feet, although there are swells along the vein of considerably greater width. The sulphurets are not considered of sufficient value to pay for the use of concentrators. The motive power throughout the works is steam, the wood consumption being one of the heaviest items of expense. As the present machinery plant will soon have reached its limits, the question of replacing the steam with electrical power, to be generated on Antone Creek, about 1½ miles distant, and then transmitted to the mine, is of vital importance, more especially since all the available timber in the immediate neighborhood of the mine has been consumed, making the cost of fuel a constantly increasing item in the expense account.

On O'Neil Creek, in the neighborhood of the Sheep Ranch Mine, to the west, some parties are running a long tunnel to cut a vein running parallel to the above. Up to the present they are in 500 feet, and expect to have 500 feet more to run before striking the vein.

From the Stanislaus River to Angels Camp the structure of the main fissure belt is rather complex, and some of the features presented would indicate perhaps a reopening. What is known as the east vein appears to run with the main vein for part of the distance between the same walls, but with a distinct division, beyond again taking its own course, throwing out to the east small fissures, which form the nucleus for the pocket veins.

Those who have worked for any length of time in the veins on the Mother Lode attach considerable importance to the material forming the walls. They believe that when the wall consists of diabase the vein makes into a pay shoot; if slate is the wall material, the fissure is largely filled with crushed slate cemented together with quartz.

Going north from Angels Camp the stage road to San Andreas follows in the general direction the course of the vein. At Hawkeye the surface

near the road is covered with large washed quartz bowlders, but the country rock is slate, quartering on the course of the Mother Lode on the east.

Near the town of San Andreas the vein crops out again, and has been worked quite extensively, though the mines are idle at the present time.

RODESINO MINE.

Situated at El Dorado. The company holds 1,500 feet by 600 feet on the line of the vein, which strikes southeast and northwest, dipping to the east at an angle of 60°, showing 18 feet of quartz between the slate walls. A shaft has been sunk and stoping done for a distance of about 120 feet. A drain tunnel 800 feet long connects with the shaft. The ten 600-pound stamp mill is driven by a hurdy-gurdy wheel, using 40 inches of water under a 60-foot head. The Table Mountain Company furnish the water, at a cost of 25 cents per inch. Twelve men are usually employed, half of them in the mine, at $2 50 per day.

SHENANDOAH MINE.

Situated in Jesus Maria Creek, 3 miles from El Dorado and 14 miles northeast of San Andreas. The altitude of the creek at the mine is 1,550 feet; at the mine workings, 1,890 feet. The company own 3,700 feet by 600 feet.

The present works have all been opened since 1889. They comprise a tunnel at the mill level 450 feet long, and 190 feet above a second tunnel, 400 feet in length on the vein. The upper one has a vertical depth from the surface of 130 feet. There is an upraise between the two tunnels. A third tunnel, nearer the surface, on the course of the vein, is 800 feet long. This is not yet connected with the remainder of the work. The vein is on a contact between slate and granite, the latter forming the foot wall. The average width between the walls is 2½ feet. To the north the pay shoot has been developed a distance of 300 feet. The vein itself strikes northeast about 25° and dips 65° to the west. There are seven miners employed, who receive $2 75 per day. The source of the timber and lagging is about a mile from the mine.

The ten-stamp water-power mill contains a rock-breaker and self-feeders. The stamps weigh 850 pounds and drop 8 inches, with a 7-inch discharge, passing the pulp through a No. 60 screen. The ore is a glassy ribbon rock, carrying very few sulphurets. At present the tailings are confined; later a concentration plant will be erected for working them. The power wheel is a 3-foot Knight, running under a 92-foot head. The company has brought the water to the mine through 2 miles of ditch.

At Central Hill, about 3 or 4 miles northwest of the town, some drift mining operations are being carried on by three or four companies in Sec. 11, T. 4 N., R. 11 E. The supposed course of the gravel channel is from the southeast, passing to the northwest through the "Shaft Mine" claim, thence across the head of Chaparral Gulch, thence through the Putnam claim into the Agostini claim, and the ground of the Rising Star Mine.

THE AGOSTINI COMPANY GRAVEL CLAIM

Has a double compartment shaft sunk 200 feet, all the way in the gravel. The course of the channel shows 40° west of north. From the shaft a drift has been started about 20 feet in length 70° east of north. From 250 to 260 gallons of water an hour comes into the mine, which is hoisted by iron buckets with automatic valves. A thirty horse-power engine is used for hoisting. The bedrock is partly slate and partly diabase. The work is carried on by six men working underground in three shifts. The work appears to be on the rim, and the drift is being run with the idea of cutting across the channel; the gravel on the bedrock prospects about 3 cents to the pan. A layer of quicksand is found, in many places resting on the pay gravel. In following the pitch of the bedrock so much water was encountered that it could not be handled with the present facilities.

RISING STAR MINE.

The shaft of this mine has been sunk 120 feet down to bedrock, from where two drifts have been run, one of 1,000 feet and a second one 500 feet. A second shaft has been started, which has reached a depth of 50 feet. In this claim the quicksand frequently lies directly on the bedrock, with lava on the top of it; in all such cases the sand contains a little gold.

THE PUTNAM CLAIM.

This property comprises 80 acres of land, and is about 3 miles northwest of San Andreas, and nearly 6 miles from the railroad. Like the previously mentioned claims it is an old river channel, covered in part with lava, above which is a bed of small creek wash, that does not prospect. This top layer is about 2 feet thick. The lava is 80 feet through, and the pay gravel beneath is from 7 to 8 feet deep. Elevation of the bedrock is 850 feet. The bedrock is slate, diabase, and sandstone. The shaft cost $5 per foot to sink; the gangways were driven for $3 a foot. The gravel is cemented, and the gold is obtained from it by milling. The channel drifts are 4 feet wide; the depth of the gravel drifts is 6 feet; about 50 per cent of the gravel consists of cobbles and bowlders. The gold is valued at $17 50 per ounce. The work is carried on with one shift of three men. All the timbering is done with pine, which is brought a distance of 6 miles. Steam power is altogether used, wood costing $2 per cord. Wages are $2 50 per day.

LAST CHANCE MINE.

Located about 4 miles northwest from San Andreas and 7 miles from the railroad at Valley Springs. This company owns 32½ acres. This claim is capped by soil only, with 200 feet of gravel beneath, the channel showing a course of 40° west of north. The elevation at the top of the deposit is 1,130 feet; on the bedrock 930 feet; the latter is porphyritic. The ground is opened by a shaft. They employ six men, who work in three shifts.

The limestone belt forks before reaching San Andreas, the two branches being about 2 miles apart. Between them there is a belt of black slate,

similar to the pocket vein formation farther south. It is in this formation, in the vicinity of and east of the town, that the Fellowcraft Mine, with a recorded yield of $100,000, is situated. The vein is 4 feet wide, pitching to the east. A shaft, full of water at present, has been sunk on the foot wall. On the west side, next to the town, is a belt of soapstone. The west fork of the limestone yields a good quality of marble, while the east portion is blue limestone. The white marble from the west belt, though very fine when first worked, turns reddish with age from oxidation of minute iron particles.

On the road from San Andreas, toward the river on the north, just before reaching Murray Creek, is a belt of serpentine one fourth of a mile wide, that has been prospected under the idea that it contained copper in paying quantities, but none was found. North and east from here the entire surface of the country is covered with gravel almost to the Mokelumne River.

COLUSA COUNTY.

By W. L. Watts, Assistant in the Field.

Among other things, the writer was especially instructed to gather any records there might be of the water-bearing strata of the valley lands in Colusa County. There do not appear to have been any very deep borings in the strictly valley lands in Colusa County, and there are only a few flowing wells. The supply of water from shallow wells is generally good, but along the foothills of the Coast Range briny and brackish water is encountered.

The mineralogical statistics of Colusa County for 1891–92 are very interesting. We have to record an attempt to utilize the brine springs near Sites for the manufacture of salt, and efforts which have been made to recover both the gold and quicksilver from the low-grade ores of Sulphur Creek.

In 1892, when the writer was in the immediate vicinity of Sulphur Creek, he learned that there had been new developments since the locality was visited in 1891 by Mr. Fairbanks. Recent work at the Manzanita Mine demonstrates what may be done with the large bodies of low-grade ore in this district; and from the large amount of vein matter in sight on other claims, as well as from the statements of their owners, it is probable that a systematic investigation will show that there is plenty of room for other enterprises.

The revival of the sulphur industry in the Sulphur Creek district, although temporarily suspended, will no doubt yet be brought to a successful issue; but the cost of transportation must necessitate economical working for a profit to accrue; moreover, the amount of ore in sight would not justify a great expenditure in a plant.

An important business is also being developed in quarrying building stone at Sites, and both the character of the stone and its proximity to railroad and water transportation make it a formidable competitor among building materials in the California market.

FLOWING WELLS.

About 2 miles west of Colusa there are some wells only 76 feet deep, each yielding a small flow of water, from casing about 4 feet above the surface of the ground.

GENERAL WATER SUPPLY.

The county seat of Colusa County obtains water from the Sacramento River and from numerous private wells.

In the town of Colusa the surface water is generally very hard and somewhat saline, but good water is obtained at a depth of from 100 to 175 feet; and immediately on the bank of the Sacramento River, and for a distance of a few hundred feet to the west of it, good water is obtained at a depth of from 45 to 50 feet.

On the bank of the river the formation is as follows:

Sandy sediment loam	18 feet.
Hard water, irregular strata of sand and clay	27 feet.
Gravel, with a good supply of water.	

A 5-inch well in this strip along the bank of the river cannot be pumped dry with a horse-power pump.

Farther to the west from the Sacramento River, and indeed to within 10 miles of the foothills, the following formation has been observed:

Clay loam, varying to adobe	15 feet.
Thin, sandy stratum, with very hard brackish water, but plenty of it.	
Yellow clay	30 to 80 feet.
Sand, generally quicksand	20 to 80 feet.
This stratum is of variable thickness, containing water, which is generally cased off on account of the quicksand. Red or blue clay. Gravel, with an abundance of good water.	

In the foothills themselves the supply of water is uncertain.

In the vicinity of Arbuckle, through what is known as the "chemise country," a tract of land formerly covered with chemise, the water lies deeper, most of the wells being 300 feet or more. The supply of water is by no means plentiful; the formation is hard, dry gravel and cement; in some places logs of wood have been passed through at a depth of from 50 to 170 feet.

SALT.

As previously mentioned, an attempt is being made to utilize the brine springs near Sites. These salt springs are situated on the Petersen ranch, in a small valley leading into Antelope Valley, in the western foothills of Colusa County, at an altitude of about 200 feet. The extremity of this subsidiary valley is occupied by a shallow lake during the winter season, which dries up during the summer. The springs are situated in the margin of the bed of the lake, and formerly quite a thick crust of salt formed during the summer. Of late years the lake has been partially filled up with "sandy wash," which lies mixed with much salt, and to a depth of several feet on a bed of bluish clay. From any boring penetrating this clay to a depth of 6 or 7 feet, salt water and inflammable gas are obtained. A sandy stratum is encountered about 15 feet below the surface, which yields a still larger amount of brine and an increased amount of gas. The area of the lake is about 25 acres. On its northern side a friable sandstone streaked with calcite is exposed, the strike being west of north by east of south magnetic, and dip west of south at a great angle. On the southern and opposite side of the lake a similar formation is exposed, with a similar strike, but the dip is east of north at an angle of about 55°.

These springs are therefore nearly conformable to what we may reasonably conclude to be an anticlinal axis, although the rock exposures are inadequate for a close determination of its direction. The locality therefore exhibits a similar geological structure to that observed in the sedimentary strata at Tuscan Springs, in Tehama County; and from fossils obtained in the vicinity, the rocks of both places appear to be of similar geological age.

These brine springs were leased by J. P. Rathburn, who has experimented in the manufacture of salt at this point. He first tried evaporating the salt in shallow ponds, but the muddy water was found

to contaminate the salt. Subsequently he built shallow vats, and found that an excellent quality of salt could readily be obtained from the brine. As stated in the Tenth Annual Report of the State Mining Bureau, a sample of salt furnished by Mr. Rathburn showed 96.84 per cent of sodium chloride, while a sample of brine yielded nearly 1,500 grains of sodium chloride (common salt) and more than two grains of iodine to the gallon. The manufacture of salt at these springs was interrupted in 1891 by a cloud burst, which wrought havoc with the salt making, and the product of the small vats employed was only 9 tons, which readily sold in the neighborhood at $25 per ton. In 1892 a company was organized, in Colusa, with a capital of $50,000, to develop this property, and to manufacture salt from these brines. It is the intention of the company to further investigate the elements contained by the mother liquors, and to utilize the inflammable gas as well as solar heat for evaporation.

THE MINES OF SULPHUR CREEK AND VICINITY.

The Rathburn Quicksilver Mines.

This group of mines consists of the May Day, Last Resort, Old Kentucky, Juniper, and Laurel. They have been worked at intervals for several years, and the ore, which has been reduced in small retorts, is said to have yielded good returns.

At the time of the writer's visit these mines were bonded to parties who were not working them, but Mr. J. P. Rathburn states that he will resume work as soon as the bond expires.

The Rathburn mines are situated on Dead Shot Ridge, a portion of the ridge forming the western side of Bear Valley, at an elevation of about 2,500 feet above sea-level. Near the eastern foot of the ridge a furnace was erected several years ago, and an abortive attempt was made to reduce the ore on a large scale.

The road to the summit has been cut in the serpentine, which evidently forms the greater portion of the ridge. The following of this group of claims were visited by the writer:

The Last Resort.—On this claim are several small shafts and openings, the shafts being partially filled with water. In one of them, at a depth of about 40 feet, there is said to be a vein of good ore about 3 feet wide, which dips to the southeast. In one of the workings entered by the writer, a large quantity of decomposed serpentine material was exposed, containing fragments of quartz; an average sample taken therefrom showed considerable cinnabar in the pan.

The Old Kentucky.—This claim adjoins the Last Resort on the north. It has several shafts, which were inaccessible at the time of the writer's visit. There was a considerable amount of loose ore and decomposed serpentine matter on the dumps, which, when washed, gave a good showing of cinnabar.

The Juniper.—This is a northern extension of the Old Kentucky. On this claim a series of open cuts and tunnels, now partly caved in, show a similar formation to that of the adjoining claims.

The Laurel.—On this claim a tunnel has been run for about 100 feet, the formation being serpentine. A shaft has also been sunk to a depth of 80 feet. As there was a bucket and rope at this shaft the writer

descended, and at a depth of 40 to 60 feet, respectively, entered drifts, which showed a serpentine formation, in places impregnated by silicious infiltrations, and in the bottom drift there was a considerable showing of vein matter. Traversing the vein matter were numerous fragments of dark-colored silicious rock, of opal-like character; similar rock was seen on the dump of many of the workings. This rock is also quite common at Sulphur Creek, and although cinnabar is frequently found adhering to the cleavage faces of such fragments, it seldom penetrates the mass.

The Elgin Quicksilver Mine.

This mine is situated on the headwaters of the southwest branch of Sulphur Creek, about 3 miles northwest from the village of Sulphur Creek. A precipitous bluff, showing outcropping sandstone discolored by the heated waters of sulphuretted springs, here abruptly rises to the southwest of the creek.

At various places on the bluff calcareous and silicious vein matter is conspicuous, and old workings therein have shown "pay ore." The principal and more recent workings are two tunnels, the lower of which is situated at the height of about 400 feet above the creek. This has been run for a distance of about 180 feet through vein matter, which is both silicious and calcareous. The silicious portion varies in color from white to almost black, and in texture from crystalline to amorphous or vitreous, and in structure from massive to "honey-combed." The calcareous vein matter also varies from crystalline to amorphous, occurring in some places as ribbon-like, and in others as stalactitic masses, the latter form being common to both the silicious and calcareous vein matter. The best pay ore is said to be of the spongy silicious variety, in which the cinnabar frequently penetrates the vesicular structure. A stream of hot sulphuretted water issues from the tunnel. The strike of the vein matter appears to be north of west and east of south; but as no definite wall is showing, the direction can scarcely be decided with certainty.

About 110 feet from the mouth of the tunnel a drift has been run, probably 60 feet to the northwest, in vein matter. At the end of the tunnel a crosscut has also been made some 80 feet to the southeast and 60 feet to the southwest; at the end of the southeast portion a gouge about 3 feet in thickness shows to the west of the vein matter. The northwest portion of the crosscut, which has also been run in vein matter, is the source of the stream of hot water before mentioned. The temperature in this portion of the workings is very high, but the explorer is fully compensated by a glimpse at the process of vein making, which the place affords. The newly formed, colored crystalline minerals, dripping with heated water, sparkle as the light of the candle falls upon them, and at many points in the face of the drift pure white stalactites grow amidst the sulphuretted steam.

Extending into the mountain amidst the vein matter beyond the breast of the workings, are several spaces yet unfilled with mineral, but the rocky walls inclosing them are lined with pure white aragonite, silicious incrustations, or yellow crystals of sulphur.

About 100 feet eastward from the mouth of the lower tunnel the sandstone crops out, having a strike of southeast by northwest magnetic, and between the sandstone and the tunnel a silicious, iron-stained rock is exposed.

The upper tunnel is situated about 70 feet above the lower. This has been run in a westerly direction in vein matter, which shows much sulphur on the northwestern side of the working. At a distance of about 40 feet from the mouth of the tunnel, a hanging wall of shale, about 1 foot thick, capped by sandstone, was struck. From that point the tunnel was run along the hanging wall, the direction indicating the strike of the vein matter to be east of north and west of south magnetic. The total length of the tunnel is 110 feet. About 15 feet from the end of the tunnel a winze was sunk to a depth of 26 feet on the hanging wall, all the way in ore. The hanging wall in the winze shows a dip to the southeast magnetic of about 45°. Good pay is said to have been taken from this tunnel. Above the tunnel much sulphur is shown, as hereinafter noted.

About 300 feet below the upper tunnel, and probably 2,000 feet to the southeast therefrom, there is a gas spring, which the writer was informed had been burning more than twelve months. The outcropping rocks near the spring are sandstone and shale, but the gas seems to come from silicious vein matter, similar to that observed in the Elgin Mine. The gas issued from a hole about 3 feet deep, and burned with a flame about 3 feet in height. Immediately above the gas spring, between croppings of sandstone, is a decomposed shale, which emits a fetid odor and inflammable gas when disturbed.

The Clyde Gold Mine.

The trail from the Elgin Mine to the Clyde is a somewhat steep ascent of about 1,000 feet, over a serpentine formation, which commences on the northern bank of Sulphur Creek. The Clyde is situated on a spur of the main ridge between Lake and Colusa Counties. This mine seems to be at the contact of the serpentine and a soft slate, or shale, traversed by numerous veinlets of quartz. Here a tongue of slate appears to stretch out into the serpentine from a main ridge of slate, which extends to the southeast. The formation to the north, northeast, east, and south from the Clyde Mine is serpentine, while to the westward slate prevails for several miles.

The Clyde Mine has been known for more than twenty years as showing croppings of auriferous rock. About 1886–87 Mr. Haskin, who lived in Colusa, relocated the claim, and sunk a shaft to the depth of about 146 feet in the slate; he struck rich gold-bearing ore, which is said to have consisted of decomposed slate. The ore was worked in a 3½-foot Huntington mill, and it is said that as high as $200 a day of twenty-four hours was "cleaned up," seven or eight men being employed. At a depth of 90 feet, a large quantity of pyrites was encountered, but the ore is said to have deteriorated. Drifts were made at the depth of 60 and 90 feet, in the hope of finding more rich ore, but the works are now caved in.

In 1887 or 1888 the property was sold by Mr. Haskin to H. M. Cooper, of Williams, who, commencing at a slightly lower elevation than that of the old workings, ran a tunnel in a westerly direction for about 100 feet, with a crosscut and two small winzes. The formation is soft slate, or shale, traversed by veinlets of quartz; at one point several feet of serpentine was passed through. The tunnel is timbered.

About three years ago a shaft was sunk on the Clyde claim, a short dis-

tance southeast from the old workings; it appears to be upon the contact of the serpentine and a steatitic clay. Much water was encountered and the shaft abandoned. A tunnel is now being run by Mr. Cooper in a northwest direction, about 100 feet below the level of the old workings, toward the contact of the serpentine and slate.

The Keely Claim.

This claim, which is situated about 100 yards southeast from the Clyde, was relocated by J. Hawkins, in 1891. Here disjointed masses of auriferous rock were found upon the surface of the ground, but none beneath. The dirt on the surface of the claim prospects a few colors to the pan. A shaft has been sunk on this claim, apparently through decomposed serpentine, but nothing of importance was discovered.

A little below the Clyde Mine, a 5-foot Huntington mill was erected to work the ore on the Keely claim. About 150 tons of ore are said to have been worked, and about $700 to have been cleaned up. The writer was informed that the mill belongs to J. W. Brinn, of Bear Valley.

The Manzanita Mine.

This mine, which has been worked at intervals for nearly thirty years, was reopened in 1885 by the Manzanita Gold Mining Company, organized in New York. They erected a mill and commenced work upon the southern end of the claim. Their plant consists of three 5-foot Huntington mills, seven Victor concentrators, three 5-foot amalgamating pans, two 8-foot settlers, a No. 1 Gates crusher, and a sixty-five horse-power engine and boiler. The ore is crushed so as to pass a three-quarter round screen, and is pulverized so as to pass through a No. 8 slot screen. The richer ore, which averages $32 per ton, nearly all gold, with a very small amount of silver, is worked in the amalgamating pans. It is a free-milling ore, as described in the Bureau's report for 1888, but the gold is so exceedingly fine that the ore has to be ground until it will pass through a No. 80 mesh screen. There is also some bituminous matter with the ore, but it does not now seem to occasion any trouble. The lower grade ore, which runs from $1 to $2 per ton in free gold, is crushed and concentrated, and worked in the pans. The tailings from this ore seldom go over 25 cents per ton. The low-grade ore is worked principally in the summer, when it can be hauled the more easily to the mine. The richer ore is worked in winter.

The work on this mine hitherto has been largely that of development, and consequently much low-grade ore has been handled. The manager states that there is a large quantity of low-grade ore in sight, which can be profitably worked, and some strata that are rich.

As is well known, the Manzanita was first located as a quicksilver mine, and subsequently the gold value so exceeded that of the quicksilver that the mine was worked entirely for the gold. Under the present management an effort is being made to recover both metals. The ore from the part of the mine yielding the quicksilver is worked by the following method: It is first pulverized in the Huntington mill, then sized by a gravity sizer, designed by G. V. Northey, manager of the works, and then concentrated. Two concentrators work the coarse ore, two the medium, and one the slum. The concentrates average a gold value of from $100 to $200 per ton, and assay about 20 per cent in quicksilver.

MANZANITA MINE, SULPHUR CREEK, COLUSA COUNTY.

Photo. by W. L. Watts, Field Assistant.

The concentrates, which were being stored at the time of the writer's visit, will be retorted and the residues amalgamated. It is estimated that by this process ores which cannot be worked to a profit by any other method will show a fair margin of gain. The manager states that ore running as low as one tenth of 1 per cent in quicksilver can be worked so as to clear expenses, leaving the gold as a profit.

The sizer above referred to is a tank, fitted with a sloping floor. At the upper end, where the pulp and water are admitted, the tank is traversed by two partitions, which act as riffles to distribute the ore in the main body of the tank. A third partition, near the exit end of the tank, acts as a riffle and restrains the coarser particles, which escape through discharge pipes in the sides near the floor of the tank. The medium and fine particles are washed over into the last compartment, the fine escaping through a discharge pipe near the center of the end, and the medium through discharge pipes near the bottom.

The ore, which was being worked at the time of the writer's visit, was mined from the foot of the mountain immediately behind the works. An open cut was here being made in a bank of what appeared to be broken angular fragments of argillite, interspersing a loose, white, pulverulent material. The formation appeared to be a decomposed talus from the mountain, but the Superintendent said it would pay to work.

Ascending the hill immediately behind the works, the formation resembles an altered argillite, white to bluish in color, varying from silicious to clayey, and having a strike of west of north by east of south. The whole mountain side is evidently altered by the action of mineral waters. The ore is found penetrating the rock and in seams, which have a trend still more to the east and west than the strike of the formation. Bituminous matter, as before mentioned, is frequently found associated with the rock, yielding sulphides of iron and mercury. As a general rule, the quicksilver rocks have a definite trend, but the gold occurs indiscriminately.

Much sulphur is found in some portions of these workings, occurring as crusts on the surface or as irregular masses in the rock.

At the height of something less than 200 feet above the creek the formation passes into an altered conglomerate, which in places shows some cinnabar. Still higher up toward the top of the mountain the conglomerate gives place to sandstone, and considerable cinnabar has been found associated with a calcareous gangue. The strike of these calcareous veins is east of north by west of south. At several places in the higher portion of the mountain cinnabar can be found by washing alluvial soil. The summit of the mountain is about 2,000 feet above sea-level and probably 450 feet above Sulphur Creek. It commands an extensive view, showing the Elgin and the Clyde in range with the Manzanita, approximately northwest by southeast magnetic.

The Central Mine.

This claim was located by Messrs. Northey & York in 1891. It lies nearly parallel to and adjoins the Manzanita on the east. Four short tunnels have been run on this claim, the highest of which is situated about 600 feet above Sulphur Creek. These tunnels have been run in an altered serpentine, and two of them penetrate to unaltered serpentine, which appears to form the core of the mountain, cropping out at the

summit and a short distance below it. The loose and altered rock shows much cinnabar, an average sample of which, it is said, yielded 1 per cent, while high-grade ore has been found in silicious seams.

The Oriental Quicksilver Mine.

This mine was first located in 1863, and worked from time to time up to 1877. In 1891, croppings of pay ore were discovered by G. T. and J. W. Farris, who located the claim and took out some ore. They state that they took out several samples of ore of from 30 to 40 pounds each, and on reducing these in small retorts they came to the conclusion that the unassorted ore, from a 4-foot pay streak showing into the ledge, would assay over 5 per cent in quicksilver, and that the assorted would go very much higher. They state that they were compelled to suspend operations, because the mine was found to be on land held under a homestead patent by J. S. Braine, of Arroyo Grande, San Luis Obispo County.

When the property in question was visited by the writer, an open cut had been run in the mountain for about 20 feet, disclosing a vitreous and white pulverulent vein matter. The vein matter exposed appeared to be about 6 feet in width, the course being west of north by east of south. It is said that the vein matter shows well in the pan, and that some nuggets of rich ore have been found. Another tunnel was commenced about 40 feet below this working; it was run in a decomposed formation, and toward the end of it is said to prospect well.

The Sulphur Creek Quicksilver Mine.

This mine was located by W. E. York and T. Persons. It is situated on the south side of Sulphur Creek and on an elevation a little more than 200 feet above it. The strike of the formation is west of north by east of south magnetic, and the dip northeasterly at an angle of about 45°. The formation is soft and decomposed, and the ore is said to follow the white clayey seams which traverse it. The workings consist of a tunnel about 85 feet in length, and a soft, decomposed material in the breast of the workings is said to yield over 2 per cent of quicksilver.

The Empire Mine.

This mine is owned by W. E. York and T. Persons. It is situated on the south bank of Sulphur Creek, its southwest boundary being about 400 feet above that stream. The surface of the mountain on which this claim is located shows cinnabar by prospecting the alluvium and decomposed rock with a pan, especially at one point near the summit, where considerable vein matter is exposed. This claim extends to the south bank of Sulphur Creek, and joins the southeast corner of the Manzanita, where a tunnel has been run into the mountain for a distance of probably 150 feet, the direction being a little east of south magnetic. About 100 feet of this tunnel was run in 1873, and sufficient ore to obtain sixty-three flasks of quicksilver was reduced in a small retort belonging to the Buckeye Mine, which is distant about three quarters of a mile in a southeasterly direction.

This property was relocated in 1890 by W. E. York and T. Persons, who continued the tunnel about 50 feet. This tunnel has been run all the way in vein matter, and pay ore is said to have been taken out in places.

The Mercury.

This claim is situated in the Sulphur Creek Mining District, on the south side of the creek. It was located in 1890 by T. B. Persons of Sulphur Creek, who ran a tunnel of about 40 feet in length, and sunk several smaller prospect holes on the claim. Mr. Persons states that the workings appear to be all in vein matter. He concentrated several samples from his mine by washing, so that the ore was contained in about one twentieth the amount of rock, and he says that the samples so treated yielded about 10 per cent of quicksilver. Mr. Persons obtained altogether about 40 pounds of quicksilver from his samples.

The Buckeye Mine.

This mine is situated about half a mile southwest from the village of Sulphur Creek, on the eastern side of the ridge dividing Colusa and Lake Counties. As noted under Lake County, the Abbott Quicksilver Mine is on the opposite and western slope of this ridge. No work was being done on this mine at the time of the writer's visit. The property is owned by W. H. Shellback, of San Francisco.

SULPHUR.

In 1891 W. L. Bromley commenced mining sulphur on the Elgin property, about 4 miles northwest from the village of Sulphur Creek. As already mentioned, much sulphur was met with in the upper tunnel of the Elgin Mine. The sulphur deposits increase toward the summit of the mountain, where Mr. Bromley uncovered a large body of this substance. The sulphur occurs associated with decomposed rock, and at one point with soft white magnesite, and in many places the formation is permeated by hot springs. He first experimented with the "calcaroni" process. Owing either to the pulverulent nature of the gangue rock or errors in the construction, the "calcaroni" was not a success; the trouble being that the "calcaroni" became "choked up," and the sulphur would not run. Another attempt was made by a Sicilian workman, who had operated the "calcaroni" process in Sicily. In this instance the sulphur burned up. Mr. Bromley then erected a furnace with three kettles, and commenced refining the richer ores, which yielded 30 per cent sulphur. His product, however, was black sulphur, and this was not acceptable in the California market, although containing 88 per cent of sulphur. In a sample of this product, which was examined by the writer, the dark color was occasioned principally by sulphide of iron and carbonaceous matter.

SULPHUR NEAR WILBUR SPRINGS.

At a point on the mountain to the northwest of Wilbur Springs, and about 200 feet above them, on the Moore property, sulphur was mined at an early day. The excavation shows altered serpentine and apparently an altered argillaceous sedimentary rock, some of which evidently contains a large percentage of sulphur. The outcropping rocks on the summit of the mountain are serpentine, while the loose rock in the excavation is for the most part whitish pulverulent and argillaceous, slacking on exposure to the air. The whole mountain's side has the

appearance of being more or less altered by the action of mineral springs. There are also similar old workings at lower elevations.

COAL.

In 1891, work was commenced by W. L. Bromley, on a coal prospect about 2 miles northwest from the village of Sulphur Creek. The formation is sandstone, with a strike of northwest by southeast. A tunnel, probably 100 feet in length, has been run to strike the croppings, which show coal of good quality interspersed with sandstone. From this formation casts of *Aucella piochii* were obtained, associated with the coal. A short distance from the above-mentioned tunnel, a prospect hole was also sunk upon coal croppings by E. Pardoe. A specimen of this coal was analyzed by Dr. W. D. Johnston, Chemist of the Bureau, and it showed the following composition:

Moisture	7.00 per cent.
Volatile carbonaceous matter	29.75 per cent.
Fixed carbon	48.00 per cent.
Ash	15.00 per cent.
	100.00 per cent.

FOSSILIFEROUS LIMESTONE.

On a ridge to the south of the Enterprise Mine, and about 400 feet above Sulphur Creek, are outcroppings of limestone, showing numerous specimens of *Rhynchonella Whitneyi*. A similar formation crops out close to Wilbur Springs, and several years ago lime was burned there for local use. This limestone, when freshly broken, smells strongly of petroleum. As recorded in previous reports, inflammable gas and seepages of petroleum occur in this vicinity.

BUILDING STONE.

The O'Neil and Abbott Quarry.

This quarry is situated on the Colusa and Lake Railroad, about half a mile east from Sites. It was opened in November, 1891, by Messrs. O'Neil & Abbott, who leased the land from J. Sites. The stone is a somewhat metamorphic sandstone, compact in texture and of grayish cast. It occurs in ledges 8 to 10 feet in thickness, dipping to the northeast at an angle of about 55°. The writer was informed that about $20,000 has been expended in developing the quarry. A mill with two gangs of saws for sawing the stone has been constructed, and the quarry is furnished with steam channelers, drills, and hoists. The developments at this quarry have shown the stone to be of uniformly good quality, and easily worked. This stone has found ready sale in San Francisco, Oakland, and elsewhere. The theater at Broadway and Thirteenth Street, Oakland, is built of it, and it is to be used in the construction of several other large edifices.

Owing to the exceptional advantages of position and transportation, sawn stone can be delivered in San Francisco from this quarry at 60 cents per cubic foot. Along the strike of this formation are several points at which quarries might be opened to advantage. On the opposite side of Stone Corral Creek to that on which the O'Neil & Abbott quarry is situated, a quarry has been opened by J. C. Sisk and R. S. Burgett.

CONTRA COSTA COUNTY.

By W. L. WATTS, Assistant in the Field.

Mining in Contra Costa County is at present confined to the coal measures of Mount Diablo, where there appears to be still a large amount of coal which can be profitably extracted.

During 1891–92, extensive alterations and improvements were made at the refinery of Messrs. Selby & Co., whose works are sufficient in themselves intimately to connect Contra Costa County with the mining interests of California.

THE SELBY SMELTING WORKS.

During the last two years important additions and improvements have been made at the works of this well-known company, which are situated on Carquinez Straits, near Vallejo Junction. A new lead refinery has been built, where a modification of the Parkes process is employed. A dust chamber and a 100-foot stack have been built, with which all the furnaces in the refinery are connected, instead of each furnace having its own chimney. A central stack and 300 feet of flue have been connected with the roasting furnaces, and the number of puddle-roasting furnaces have been increased from three to four. The three blast furnaces used by this company have also been connected with a 180-foot flue and dust chamber. The saving effected by these new flues and dust chambers has been estimated at about $15,000 a year. A condensing chamber has also been built for saving the sulphuric vapors arising from the parting department. This chamber is lead-lined, its dimensions being 150x2x2 feet. Any vapor escaping from this condensing chamber passes into the 100-foot stack of the refinery.

The blast furnaces have a capacity of 60 tons each for twenty-four hours; they are furnished with separate tap holes for slag and matte, and a syphon tap with lead well for bullion.

The slag is used for riprap work and extending the ore yard into the shallower portions of the straits. The matte is roasted and returned to the blast furnace, where it is smelted for second matte, containing about 40 per cent of copper. The second matte is roasted, pulverized, and used for making bluestone, together with the copper solution from the parting room, hereinafter described.

The base bullion is treated in the softening furnace. The softening furnace is a reverberatory furnace, in which the bullion is subjected to a dark red heat without blast. Under these conditions the oxide of arsenic and antimony collect upon the surface of the bullion. The oxide of arsenic is the first to form as a stiff scum, which is skimmed off; next the oxide of antimony, which is also skimmed off. If the scums are too thin, quicklime is added to thicken them. When the last scum is removed the process of softening is complete, and the resulting

bullion contains only silver and gold, and perhaps a little copper. The oxides of arsenic and antimony, when skimmed from the surface of the bullion, get mixed with some metallic lead and oxide of lead. The scum of arsenic is returned to the blast furnace. The scum of antimony is desilverized, and then reduced to a metallic state.

The desilverizing furnace is a reverberatory furnace, and in it the scum of antimony from the softening furnace is subjected to a low red heat, and treated with coal slack, sawdust, or any reducing agent, by which a bullion carrying lead, some antimony, and gold and silver is formed; also antimony slag, consisting mainly of the oxides of lead and antimony, and practically no silver. The bullion from the desilverizing furnace is returned to the softening furnace. The antimony slag is reduced to a metallic state in a blast furnace, forming antimonial lead, carrying about 40 per cent antimony. The bullion, which is, of course, the main product of the softening furnace, is treated, as before mentioned, by a modification of the Parkes process. In the zincing pots of this process it is melted and treated with about one pound of zinc for every ounce of gold or silver the bullion may contain. The zinc is added in three separate charges. After being thoroughly mixed the contents of the zincing pots are allowed to stand and cool for half an hour, when a zinc scum, which is an alloy of gold, silver, lead, and zinc, and copper if present, rises to the surface; this scum is removed and the remaining lead contains less than 10 cents in gold and silver to the ton.

The lead bullion, which contains perhaps one half of one per cent of zinc, is drawn off into market lead furnaces. In these furnaces, the lead is subjected to a low red heat, and a zinc dross forms, containing 70 or 80 per cent of lead, which is returned to the blast furnace; the refined lead bullion is then market lead, and is run into pigs for shipment.

The skimmings from the zinc pots may be regarded as a "wet alloy" of lead, with zinc, gold, and silver, and possibly a small amount of copper. This alloy is treated in a "sweat furnace," *i. e.*, a reverberatory furnace, where a low temperature is employed. In this furnace, a bullion containing from 60 to 80 ounces of precious metals to the ton separates from the residue and is returned to the softening furnace. The residue is a dry alloy of lead, zinc, gold, and silver, and any copper that may be present. The dry alloy is then retorted in graphite retorts, where the zinc is driven off; 65 per cent of zinc is recovered and used again in the zincing pots. When the zinc is driven off, the dry alloy forms high-grade bullion, which is cupelled. The products of the cupellation are litharge, carrying off any copper that may be present (which is returned to the blast furnace), and gold or silver bullion. The gold and silver bullion is parted by sulphuric acid, and the silver precipitated from the resultant solution by metallic copper. About 50 per cent of the sulphuric acid fumes from the parting process is recovered by condensation, in the condensing chamber previously mentioned.

The copper solution resulting from this process contains a large amount of free acid, which is used for treating the second matte, as previously stated; the sulphate of copper is crystallized and sold as bluestone—more than 1,000 tons of bluestone being manufactured annually in this department. The residue from the second matte, which remains undissolved, and contains gold, silver, and lead, is returned to the blast furnace.

The annual output from the Selby Reduction Works is about as follows:

Reduced from ore—Gold	$12,000,000.
Silver	$7,000,000.
Lead	8,000 tons.
Bullion, etc., refined	$20,000,000.

The rates for treating gold and silver ores and concentrates at the Selby Works are no higher than those of Eastern reduction works, and the freights from all parts of California to the Selby Works are necessarily lower than to Eastern refineries. Under these conditions, there is no excuse for smelting ores or concentrates leaving this State.

Lime from the Dickie ranch, near Suisun, in Solano County, is now used extensively as a flux at these works. At the time of the writer's visit a new contract for 2,000 tons was being made, several thousand tons having been used since the attention of this firm was drawn to the deposit by the California State Mining Bureau, in 1891.

A large amount of the lead reduced by Selby & Co. is used at their shot tower and lead works, in San Francisco, where they manufacture lead pipe, sheet lead, shot, solder, etc.

An important branch of the business of the Selby Works is the manufacture of the Standard machine-loaded cartridges (Chamberlain patent). At the cartridge factory, located adjacent to the smelting works, eight machines, working automatically, turn out an average of 12,000 cartridges a day to each machine.

EMPIRE COAL MINE.

The Empire Mine and Railroad, as is well known, is operated by Messrs. Belshaw & Judson. Their coal property embraces about 760 acres. During 1890–91 mining was carried on by them at West Hartley and at Stewartsville, about one hundred men being employed.

The output of coal from the mines operated by this firm, for the two years ending with May, 1892, has averaged about 2,500 tons a month. Most of this was shipped from Antioch, and some carried by the S. P. R. R. The price has averaged $3 50 a ton, f. o. b. at the wharf, or on the cars at Antioch. A portion of this coal came from Stewartsville, and a portion from West Hartley.

At the time of the writer's visit to Contra Costa County, in May, 1892, work was being carried on by Messrs. Belshaw & Judson at Stewartsville, and at Cocoran's Mine.

At the latter mine a slope of 425 feet had been run in a southerly direction at an angle of about 26.5°, the dip of the formation being about 26° to the north. The first "lift" run upon this incline was at a depth of 212 feet, where the vein, which is known as the "Little Vein," was 2 feet 4 inches in thickness. All the coal was worked out of the first lift, and the incline continued to a depth of 425 feet. At this depth a drift was run back to the vein for a distance of about 420 feet, the vein there being about the same thickness as before noted. Mr. Belshaw states that about 15,000 tons of coal have been taken out of this mine since it was reopened by this firm; the output was good, clean coal. The water is controlled by a 300-gallon tank, which is hoisted about seventy times in twenty-four hours.

Mr. Belshaw also states that a new vein was struck while running an

air shoot in the Central Mine, at Stewartsville. This vein lies between the Black Diamond and the "Little Vein," being about 225 feet horizontally to the south of the "Little Vein." This new vein was 3 feet thick when first struck, and when encountered at a higher level, in the air shoot, about 150 feet above, it was found to be about 2½ feet in thickness. When struck at a still higher level, about 500 feet above the point where it was first observed, it was found to be about 2 feet in thickness; but 80 feet nearer the surface, the quality of the coal had deteriorated. The new vein was named the "Belshaw Vein."

THE PITTSBURG COAL MINE.

The shaft, which was commenced in 1889, was finished in 1891, terminating at a depth of about 600 feet. The shaft penetrated the old workings on the "Clark Vein," at a depth of about 300 feet, and the "Little Vein," at a depth of about 450 feet. The dip of the formation at this point is to the north at an angle of about 30°. The "Little Vein" at this depth showed a thickness of about 18 inches. From the bottom of the shaft a tunnel was run in a northerly direction, which intersected the "Little Vein" at a distance of about 160 feet from the bottom of the shaft. At this point the "Little Vein" showed a thickness of 2 feet 2 inches of good coal. The water was controlled by a tank holding 380 gallons, which was elevated by the hoist used for raising the coal and rock.

It is the opinion of Mr. Rankin, the Superintendent of the mine, that the coal probably increases in thickness from this point westward along the strike of the vein; for in the old workings of the Eureka Mine, distant about 1,000 feet in a westerly direction, the vein showed a thickness of 2 feet 6 inches of good coal. Mr. Rankin states that a vein of these dimensions could be mined at a profit, calculating the coal at $3 50 per ton, f. o. b. at Pittsburg Landing.

It is the intention of Mr. Rankin to drift farther north to the "Clark Vein," which would be struck at a distance of about 350 feet from the bottom of the shaft. This vein, in other workings of the Pittsburg Mine, showed from 3 to 4 feet of good coal. The largest portion of the vein upon this property remains intact. Prospect work was suspended on these levels in consequence of the low price of coal. The company, at the time of this writing, was working the "Black Diamond Vein," at a point about 1,000 feet west from the new shaft.

In 1891–92 the main incline on this portion of the property was extended about 227 feet in a southerly direction, and a drift was run from the end of it in a northerly direction for a distance of 320 feet before the vein was again struck. The formation penetrated was similar to that in the other workings, the pitch being from 26° to 30° to the north. At this point the "Black Diamond Vein" showed a thickness of 3½ feet of good coal.

Mr. Rankin states that the price of coal at the Pittsburg Landing averaged, during 1891–92, from $3 to $3 50 per ton. The company operating these mines was incorporated in Contra Costa County, October 1, 1861, under the name of the Pittsburg Mining Company. This company now controls the property of the Eureka and the Independent Mines, comprising about 480 acres of coal land, of which Mr. Rankin states that there are about 200 acres of good coal land yet untouched.

WATER AND WELLS.

The proprietors of Byron Springs, after boring 116 feet through the conglomerate, succeeded in obtaining only brackish water; they therefore abandoned the idea of obtaining a supply of fresh water from the solid formation around the springs, and established a pumping plant to pump water from the San Joaquin River 2¾ miles distant, and about 90 feet below the hotel grounds. For this purpose, a Dow pump, having a capacity of 55,000 gallons per hour, is used and operated by a forty horse-power engine. The pipe-line is 6-inch pipe, 4,700 feet of it being supported on trestles over the "tule," and the remainder buried 3 feet beneath the surface of the ground. In driving stakes for trestle, the "tule mud" was found to be, in many places, 30 feet in depth.

On the Quinn ranch, 4 or 5 miles east from Martinez, on the Government tract, a flowing well is said to have been obtained at a depth of 80 feet, which yielded an inch stream of water.

Shallow flowing wells are reported in the Pacheco Valley; also, on the east side of Walnut Creek, near Concord, a flowing well was obtained at a depth of about 160 feet, the water flowing just over the top of the casing. On the west side of the creek borings have been made to the depth of 300 feet without obtaining flowing water.

At Walnut Creek, near Concord, the following formation has been observed:

Sandy loam	50 to 60 feet.
Yellow clay	3 to 20 feet.
Gravel	1 to 2 feet.

This last stratum contains a good supply of water, but it does not rise in the casing.

In and around Martinez, dug wells on the bottom lands have shown a clayey soil, passing into bluish clay for a depth of from 30 to 40 feet. Water is found in thin strata of sand and gravel, with which the clay is interstratified.

In 1877–78 several borings were made by the S. P. R. R. Co. in the bed of the Carquinez Straits, between Benicia and the Contra Costa shore, toward Martinez. A bedrock of sandstone, overlaid by a thin stratum of red clay, was struck beneath about 40 feet of river mud, clay, sand, and gravel. One of the borings a short distance from the Martinez shore showed the following formation:

Water	36 feet.
Soft mud	14 feet.
Soft mud and clay	18 feet.
Sand and gravel	3 feet.
Very stiff clay	3 feet.

Beneath the stiff clay sandstone was struck.

When the writer last visited Martinez, several citizens questioned him with regard to the possibility of obtaining water from flowing wells at Martinez in sufficient quantity to supply the town. It is evident from the position of Martinez, that the geological conditions are not present to warrant any one calculating on obtaining a flowing well of great volume in that neighborhood. It is not impossible that small veins of water might be struck by boring, such as give rise to springs, or accidentally to shallow flowing wells, in hilly or mountainous portions of the

country; but it is unlikely that any flowing well could be obtained by boring that would yield a sufficient volume of water to supply the town.

It is certain from the position of Martinez, and this is corroborated by the borings of the S. P. R. R. Co., that the bedrock can be at no great depth. The experimental wells, bored at Benicia and at Byron Springs, attest what has frequently been shown, viz.: that the wells bored in the sedimentary bedrocks are seldom very satisfactory. When the water has to be sought in the solid formation, a tunnel is usually preferable to deep boring. It is more than likely that the best and most reliable subterranean water supply at Martinez is to be found on the face of the bedrock, or in a clayey stratum covering it, probably at a depth of something less than 100 feet. If an experimental boring should show this to be the case, a dug well of great diameter would afford the best supply.

DEL NORTE COUNTY.

By W. L. WATTS, Assistant in the Field.

At the time of the writer's visit to Del Norte, in 1891, the mining interests of the county were practically confined to placer mining on a small scale along the tributaries of Smith River.

As a perusal of the following pages will show, Del Norte is one of the few places in California where the poor man still earns a living with sluice and rocker, and recent prospecting has demonstrated that there are deposits of auriferous gravel in the county which are yet unworked. Although the position of many of these deposits seems to place them above the reach of the streams, it is probable that they could be worked by impounding rain water; more especially as the rainfall in the northwestern corner of California is somewhat excessive during the winter months. It is also more than likely that there are auriferous gravels in places now covered with forests, which will some day be available. In some places near the seashore, unaltered sandstone sometimes affords a good building material. Inland, the principal geological features to the west of the Siskiyou Mountains are the large belts of serpentine, which here and there are interspersed with more or less metamorphosed shales and sandstones, or pass into talcose slates. The latter formation, which is traversed by numerous little quartz veins and veinlets, extends throughout a large area in the southern portion of Del Norte, and into Humboldt County, where it is first encountered on the seashore to the north of the Big Lagoon. The more compact serpentine appears to be the repository of the chrome and the copper, while its few auriferous veins are not sufficient to account for the gold-bearing sands and gravels which have been deposited during recent geological times. It is probable that the numerous quartz veins and veinlets traversing the talcose slate were the original habitat of much of the placer gold in Del Norte County, for not only does the slate in many places form the bedrock of placer workings, but the gold on its surface is frequently found with rough quartz adhering to it, showing that it has not traveled very far. On the other hand, it appears from the character of some of the pebbles in the auriferous gravels, that a portion has come from other formations in the Siskiyou Mountains.

A large amount of chromic iron still remains in Del Norte County, awaiting the time when the demand for that mineral shall warrant its being mined and placed upon the market.

The copper interests of Del Norte County at present appear to be at a standstill.

PLACER MINING.

Myrtle Creek Placer Mines.—Placer mining is carried on to a limited extent on Myrtle Creek, which empties into the main fork of the Smith River about 10 miles above its mouth. The formation is gravel and

cement. These placers were first mined by Louis Gallise in 1853. Lack of water has heretofore confined operations to the winter months, but a new ditch is now nearly completed, which will allow work to be continued during the greater portion of the year. The gold at Myrtle Creek is all coarse gold. About three years ago a nugget valued at $800 is said to have been found there.

The Siskiyou Fork of Smith River.—New placers have been discovered on this stream, and locations have been made by Jenkins Bros., who have commenced work thereon. It is said that there is a good water supply at this point, and that work can be prosecuted there nearly all the year round. The field occupied by these gravels is said to be extensive, but they have not been sufficiently prospected to define their actual limit.

Bald Hill.—Gold sluicing is carried on at Bald Hill during the winter months.

Big Flat.—Mining is still suspended at the Big Flat Placer Mines, in consequence of litigation. These mines are situated upon Hurdy Gurdy Creek, a tributary of the South Fork of Smith River. A freshet in 1889 greatly damaged the ditch, which conveyed the water a distance of about 9 miles from the upper portion of Hurdy Gurdy Creek to these mines. The company in possession of these mines holds a claim which extends over about 640 acres, on the east bank of Hurdy Gurdy Creek. For seven or eight years they prosecuted hydraulic mining, and at one time they employed more than three hundred men. It is said the water right controlled by this company was generally sufficient to supply the mines for about eight months of the year. The yield was coarse gold, and in a clean-up of $1,600, pieces of gold worth $20, and sometimes worth $40, were obtained, pieces worth from $3 to $5 being of frequent occurrence. The largest piece ever found at these mines weighed 5½ ounces. The gold was worth $15 50 an ounce. Fragments of quartz were frequently found clinging to the gold. The bedrock is a talcose slate, traversed by numerous small veins of quartz.

French Hill.—Hydraulic mining is carried on at French Hill, on the Middle Fork of Smith River, near Gasquet, where a "small giant" is in operation; there is also some washing with sluice and rockers.

Craig's Creek.—At Craig's Creek placer mining and ground sluicing are still kept up, the plan employed being to sluice off the top dirt and mine the bottom with pick and shovel. It is said that returns from this creek have been very satisfactory, and that several parties have earned good wages there during the past few years.

Mill Creek.—Drift mining and sluicing are carried on by H. Rice, who owns the mining right of about 20 acres on Mill Creek. His claim is about 6 miles east from Crescent City. He states that for the last twenty-three years he has made a comfortable living by these means. The gravel at this point is from 10 to 20 feet in thickness, and the owner says that on the western end of his claim the gravel on the bedrock shows from 3 to 25 cents to the pan. Mr. Rice has prospected this gravel in an easterly direction to a point about half a mile from his house, where the gravel forms a spur, which runs down from Bald Hill, and is crossed by the Old Kelsey trail. Up to this spur he found that the gravel paid for ground sluicing. The gold he obtained was all coarse gold, some pieces being worth $20 each. Mr. Rice ran several tunnels into the gravel on the above mentioned spur, in order to find the old

channel. Upon the bedrock he discovered the trunks of several redwood trees, some of which appeared to have grown upon the spot. The gravel taken from the tunnels, however, paid him only 50 cents a day. Mr. Rice also prospected the gravel in a westerly direction from his house and found pay dirt as far as the eastern bank of Mill Creek, which is distant about a quarter of a mile. Crossing to the western bank of this stream he found a similar gravel, which paid as high as $4 to the wheelbarrow load. The bedrock at this point is somewhat metamorphosed shale, with veinlets of lime and a little quartz. A few yards westward from Mr. Rice's workings, on the western bank of Mill Creek, the writer observed a somewhat altered sandstone, standing at a great angle, the strike being east of north by south of west magnetic, and the dip probably east of south.

Goose Creek.—Prospecting on Goose Creek is said to have shown that small wages could be earned there with sluice and rocker, probably $1 50 a day.

Jones Creek and Vicinity.—Parties who had prospected Jones Creek and the headwaters of the South Fork of Smith River informed the writer that small wages could be made by washing upon these streams.

Coon Creek.—A few years ago some washing was done on Coon Creek and its tributaries, and it is said that there are extensive deposits of gravel there, which would pay by hydraulic washing.

Clark Creek.—Drift mining is still prosecuted on Clark Creek near Peacock's, and those engaged in the work are said to earn fair wages.

BEACH MINING.

At Pebble Beach, about 2 miles north from Crescent City, H. Raymond and others operated with a Wood & Garcelon machine in the spring of 1891. A run of about thirty days was made, and seven men were employed. It was a four-pan machine, and was run by a six horsepower engine. The sand, however, is said to have yielded only 10 cents a ton, which was not sufficiently high grade to pay for handling. In 1890 L'Hote, of Napa, experimented with a gold-saving machine on the seashore at Crescent City, but, according to all accounts, it was not a success.

QUARTZ MINES.

Oranna Mine.—The Crescent City Mine was relocated in 1889 under the name of the Oranna Mine. The average of the ledge is said to assay $26 90 in gold and $1 10 in silver. The mine is owned by J. E. Murphy and parties in Crescent City, who intend to erect a small mill to work the ore.

Myrtle Creek Quartz Mine.—At Myrtle Creek, a quartz mine and a small mill were operated for about three years up to the time when the mill was destroyed by fire.

Last Chance Mine.—Two years ago, J. Byron located a quartz ledge under the name of Last Chance Mine, about 1 mile south from Gasquet. The ore is said to have shown $7 per ton in free gold.

Preston Peak.—Some valuable discoveries of gold-bearing rock are said to have been made on the Del Norte side of Preston Peak, but the writer failed to meet any of the prospecting party.

COPPER.

Nothing was being done at the various copper properties in Del Norte County, at the time of the writer's visit.

At the Condon Mine, which is about 38 miles east of Crescent City, the formation is serpentine. The workings at this mine consist of upper and lower tunnels, which for the most part are now caved in. In this mine there is said to be a vein of copper ore 8 or 10 feet thick. The only copper ore which the writer saw at the Condon Mine, besides what was on the dump, was at the mouth of one of the tunnels, where a vein of ferruginous rock showing some copper has been cut through. On the dump are a good many tons of magnetic iron and some copper ore.

There is no road to the Condon Mine, and beyond Big Flat the trail is obliterated.

At the Low Divide the formation is serpentine. At the time of the writer's visit, there were several tons of copper and iron pyrites on the dump, some of which was high-grade ore.

On the eastern side of the divide, between the North Fork of Smith River and Diamond Creek, cuts and tunnels have been made in the serpentine. Around some of the cuts, at the time of the writer's visit, copper ore, principally sulphide, was scattered; some of the ore was high-grade. The writer collected an average sample of this ore; it showed 9 per cent of copper, and had no value in gold or silver.

The now abandoned Oregon stage road runs from Smith River past the Low Divide and Diamond Creek. In 1891 the old road was still passable for light vehicles with good teams, but the bridge over the North Fork of Smith River at Rocklin has been carried away. The river at Rocklin is fordable, except after heavy rains. The restricted dimensions of this report necessitate the omission of the writer's observations on the copper mines of Del Norte County.

QUICKSILVER.

Several years ago some quicksilver claims were located on Diamond Creek. A vein showing cinnabar and native quicksilver was also discovered in T. 18 N., R. 2 E., H. M., and a shaft about 18 feet in depth was sunk. The formation is serpentine. The property is now owned by F. L. Cooper and H. A. Henry, of Crescent City.

COAL.

At Point St. George, about 2 miles north of Crescent City, coal measures crop out on the beach below high-tide mark, and at low water quite a body of coal is said to be exposed.

About six years ago, W. H. Hodgkins, of Crescent City, made two borings, each 160 feet in depth, about 400 yards inland from the coal croppings, and fully three quarters of a mile apart. A vein of coal about 4 feet in thickness was struck in each instance. It is said that this coal exhibited a wood-like texture. Mr. Hodgkins then bored two other holes, each to a depth of 506 feet; one of these was a mile, and the other a mile and a quarter inland from the coal croppings on the beach. Although several pieces of coal were found, no vein was struck. In none of these holes did the water rise to the surface.

BUILDING STONE.

On the Edwards ranch, about 2 miles east from Crescent City, there is a sandstone suitable for building purposes. It is said that this stone was examined and approved by the Lighthouse Board and would have been used by them, but a dispute arose as to the price. The rock is a compact, micaceous sandstone, and crops out near the roadway, where a small amount of stone has been quarried, and where a breast of about 10 feet is exposed. The strata dip in an easterly direction, at an angle of about 15°. The stone is bluish when freshly quarried; some of the strata are of brown sandstone. From the quarry a bench of sandstone extends a distance of about 100 yards to a mound of similar rock, the greater portion of which stands on the land of J. E. Murphy. This mound is probably 2,000 feet in circumference and the top of it is about 50 feet above the roadway. No doubt similar rock could be found in the range of hills which rise still farther to the eastward of Crescent City.

EL DORADO COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

GEORGETOWN DIVIDE.

This mountain spur, which extends from Loon Lakes, on the m ridge of the Sierra, to near Folsom, on the edge of Sacramento Val drops, in a distance of about 52 miles, from an altitude of over 8, feet down to 175 feet above sea-level. It forms the divide between South and Middle Forks of the American River, the latter being boundary line on the north between Placer and El Dorado Coun Its eastern and western extremities are both in granite, while betw are the metamorphic and eruptive rocks as found covering the flank of the Sierra Nevada farther south. The north slope of the Di has yielded largely to hydraulic work, gravel deposits being found tinuously from the headwaters of Pilot Creek to beyond Greenwoo the west, while crossing from southeast to northwest is the mineral belt of the Mother Lode, extending from the Big Cañon on the s side of the South Fork of American River, near Chile Bar, to w American Cañon empties into the Middle Fork. In this latter be included the seam diggings or porphyry belt for which the Divi noted, and which has added so materially to her annual bullion out It comprises, roughly estimated, an area 20 miles long by 10 miles extending north and south. A large portion of the surface of the nort slope, from the headwaters of the California Water Company down t vicinity of Georgetown, is covered with cement, which appears to fea out in that vicinity. Beneath it, cropping out over large areas, we the auriferous slates with dioritic dikes interspersed; also diabasic in all conditions of decomposition, from the solid rock formatio the reddish clay loam, and just to the east of the town of Georget at Hotchkiss Hill, 3,217 feet high, where it is over half a mile a belt of serpentine, coursing nearly north and south.

Considering the area of the Divide, it is extremely well watered, numerous creeks and cañons carrying water showing two distinct tems that may, possibly, have a bearing on the location of the g channels, which are far from being throughly understood and explo All the waters on the north side of the backbone ridge, indicated i map by the main road down the Divide, show a general trend from to west, until they unite with the Middle Fork; while those on the s of this division have their sources on the flank of the Divide, and a general north and south direction, draining into the South For the American River, showing the presence of a large amount of terranean water along the crest of the ridge. This fact was verifi some extent by the large quantities of water encountered in the sin of the shaft in the Woodside Mine, in Georgetown. The entire w shed of the Divide covers an area of over 1,000 square miles.

Although the auriferous slates of this section were among the first worked in the history of gold mining, the Divide has not received the attention, nor has it been explored to the extent that the counties both north and south have. This may be attributed partly to the fact that the Mother Lode does not crop out as boldly and conspicuously here as farther south, and also to the fact that at the time of the Comstock excitement (the road up the Divide being the main route to the new mines) it was hurried over without receiving any attention, and when the rush had ceased fell back into comparative desertion. Notwithstanding this condition of affairs, the Georgetown Divide has continued to add every year a very respectable amount to the gold production of California, with a good prospect of continuing and increasing the same for years to come, as her wealth in deposits of various kinds becomes better known.

To reach this section of country from Placerville, the county seat, the road traveled follows on the western side of the Mother Lode, going north, down the entire Big Cañon, from its head to where it emerges on the South Fork of the American River, descending 850 feet in 3 miles. Across this cañon, where the quartz crops out continuously, are located the Brown Bear, Grizzly Bear, White Bear, and Cinnamon Bear mining claims, which are not doing much active work. A serpentine belt is on the east side of this outcrop and is continuous north through the Divide; on the west the formation is slate. At Chile Bar, where the road crosses the river (the aneroid reads 1,000 feet), the black slates, standing almost vertical, have such a regular and complete cleavage that two quarries have been established for the production of roofing slates, which are finding a ready sale. A similar formation on the same course has been exposed near the head of Missouri Cañon, on the north slope of the Divide. Following the course of the slate east of north, the road ascends the north bluff of the river cañon to the village of Kelsey. The Mother Lode passes through here a little west of the town. In this neighborhood Marshall, the discoverer of gold, had his home, and not far from here was where the notable find was made.

DALMATIA MINE.

To the southeast of the village, about one quarter of a mile, is the location of the Dalmatia Mine. In several respects this property is of interest to the mining men in California, as showing what may be done under favorable circumstances in the matter of expense in mining and milling gold ores. The mine is on the so-called porphyry seam belt, containing pockets of rich quartz in small veins scattered through the bedrock. The ground has been worked as an open cut on the course of the vein down to the level of the tunnel, which is connected with the mill by a tramway, and the ore was delivered in the mill by contract for less than 10 cents per ton, the expense of milling bringing the whole cost up to 43 cents per ton, which price, as far as the writer is aware, is the lowest reached in the State. At the present time they have started to sink on the vein, which increases the expense somewhat, but the parties assert that the total cost is still within 50 cents per ton.

The plant, which consists of ten stamps and a Huntington roller mill, has been run during the last year and a half with electric power, generated at a distance of 2½ miles. Only two men are required to run the

mill, the motor requiring little or no attention, never having caused a stoppage of the works through repairs. As the mill does not consume all of the power, a part of it is carried beyond to the St. Lawrence Mine, belonging to the same parties, where it is used for hoisting in a prospect shaft that they are sinking.

So thoroughly satisfied are the parties with the advantages of using electricity both in milling and mining operations, that they are taking the preliminary steps to cut a canal capable of carrying 6,000 inches of water, and to erect a fifteen-hundred horse-power electrical plant.

From Kelsey the road continues north through a slate country, with a serpentine belt to the east, until Georgetown is reached. The principal outcrops of the Mother Lode are to the west, but there are mines to the east, and near Georgetown, including the seam diggings, which should belong within the east boundary of this belt.

THE DARLING MINE.

This mine is located near Rock Creek, in the Slate Mountain range, 3 miles northeast of American Flat. The vein is in the characteristic black slate, and carries the black gouge of the Mother Lode belt. The strike of the vein is nearly magnetic north and south, dipping almost vertically. It carries ribbon quartz, yielding from $5 to $6 in free gold, with calaverite and petzite (tellurides of gold and silver).

The perpendicular shaft is 190 feet deep, with double compartments, supplied with a steam power hoist, single reel, with steel rope and pumps. On the 90-foot level the drifts extend 50 feet to the south and 30 feet north, the ground from here to the surface having been stoped out. The pay shoot extends 130 feet, and shows a slight pitch to the north. A ten-stamp steam mill with 750-pound stamps contains self-feeders and two Frue concentrators, only one of which has been put up. The batteries are supplied with plates on the inside, both back and front, and aprons 4x8 feet, supplied with silvered plates. Litigation among the parties has put a stop to the work.

To the north of this mine, on a vein having the same course and general characteristics, is the Belcher mining property.

The dikes of diabase and diorite, which along the Mother Lode belt, in the more southern counties, are found with small seams of quartz running into and through them, are here replaced by the talcose and chloritic schists and so-called porphyry belts, with similar quartz seams. The agencies at work in the decomposition of the rocks were in greater activity or in larger quantities in this part of the country.

GEORGETOWN.

This town is situated on the exact watershed of the Divide, and water on the main street of the town finds its way partly to the South Fork, partly to the Middle Fork. The altitude is given by Professor Whitney as 2,500 feet; other readings give it at 2,700 feet. The formation consists of argillaceous and talcose slates, bordered on the east by an extensive serpentine belt, about half a mile across. Opposite the town, Hotchkiss Hill, 3,217 feet high, is on this belt. To the west is the porphyry seam belt, which may be roughly stated to be several miles wide and extending well across the whole Divide from north to south. A

number of cañons, more or less known for their yield of the precious metals, head in the immediate vicinity of the town. They are the West, Illinois, Oregon, North, and Dark cañons, draining into Cañon Creek and the Middle Fork; and the Empire, Manhattan, Badger, Iowa, Rock Cañon, and Traverse Creek, flowing into the South Fork. Crossing the townsite is a belt of auriferous slates, in which is the Woodside Mine, now idle, being unable to control the large amount of water flowing into the mine. Adjoining on the north is the Eureka Mine; this property had two veins and a well-equipped mill, but succumbed to poor management. From all indications it is a property that would well repay being opened by proper methods. Still farther to the north is the Vann Mine, on the same belt, now being prospected.

Immediately north of town, between Illinois Cañon and Oregon Gulch, is Mameluke Hill, famous in the annals of Georgetown for the wealth it has produced. It consists of a deposit of alluvium over 200 feet deep, with drift beneath resting on pipe clay. Under the clay is gravel, filling a basin-like depression in the slate, probably an ancient lake bed. The gold, which was coarse and black, was found in a gravel bed about 2 feet thick, also wedged down a foot or more in the cleavage of the slate. In one part of the bedrock a seam of cellular quartz was met with, deeply stained with iron rust, coursing north and south, standing nearly vertical, which, upon being sunk on, yielded largely in gold.

To the north of the Georgetown cemetery, crossing Oregon Gulch and extending to the North Cañon, following down to where it enters Cañon Creek, is a belt of decomposed schistose rock, carrying seams of a white, glassy, auriferous quartz containing some iron pyrites. It has a northerly course, with westerly dip of about 70°. Between the decomposed masses are occasional strata of chloritic slate, also carrying pyrites. Here is the small mining town of Georgia Slide, occupying parts of Secs. 3 and 34, in T. 12 and 13 N., R. 10 E., where four different companies are at work: The Blue Point claim, occupying 27 acres adjoining Cañon Creek; next south the Pacific claim, holding 6 acres; above them is the Beatty claim of 36 acres, and lastly the Parsons claim, with 20 acres. The method of working this ground consists in breaking down by large blasts in the bank and washing the debris with hydraulic power. Wherever quartz specimens containing gold are found, they are sorted out and crushed in the hand mortar. The decomposed slate carries from $2 to $3 per ton in gold. The value of the gold is $18 50 per ounce; it is of a coarse nature. The Beatty claim has worked continuously since 1853; the Pacific and Blue Rock since 1856. The former takes its water supply from Cañon Creek, and has about 1,500 feet of sluices lined with blocks; it owns its dumping ground. The Pacific Company draws on North Cañon for a water supply, while the Blue Rock takes its water out of Dark Cañon. Notwithstanding forty years of continuous work, the face of the bluff is only 150 feet deep and has not reached the level of the river. An agreement exists between the companies, by which the grade is only lowered by mutual consent. The properties are worked by the owners, and pay a steady dividend.

The first seam diggings were discovered at a locality 5 miles northwest of Georgetown, on the top of a hill overlooking the Middle Fork, called Spanish Dry Diggings. Two companies worked there, in what is known as the Spanish Mine, on a quartz vein running parallel with the slates,

with two main pay seams about 100 feet apart. As at Georgia Slide, the whole belt is blasted down and washed through sluices.

At the French claim, south of the Spanish Dry Diggings, the width of the seam belt is 200 feet. Its course is 37° east of north, with a dip of 75° to the east. On the west side of the main quartz vein in the belt, which is about 4 feet wide, is 100 feet of the so-called porphyry, while the east side consists of decomposed slate rock. The porphyry can be seen in all stages of decomposition, from solid rock to a red clay loam.

Opposite to Georgetown, between Cañon Creek and the Middle Fork of the American River, are three detached hills, all showing remains of what would appear to be separate channels that had a northeasterly course, but which have been entirely removed by the present east and west drainage erosions, leaving these three elevations only, known as Bottle Hill, Cement Hill, and Jones Hill.

JONES HILL DIGGINGS,

Situated on Secs. 20 and 29, T. 13 N., R. 10 E., 5 miles northwest from Georgetown, contain 120 acres of an old river channel, whose apparent course was 55° east of north. The channel is about 200 feet wide, and has very little grade, sloping to the southwest. The depth of the cut is about 200 feet from top to bottom. The altitude on the bedrock is 2,150 feet, as read by aneroid. One hundred feet above is a false bedrock, on the west side of which the gravel contains numerous lava bowlders. The slate bedrock, which courses 55° west of north, dipping nearly vertical, is rounded and smooth. The gravel averages 8 feet in thickness, is cemented, and prospects evenly throughout. The gold is part coarse, part fine, and that which is on the upper floor is of better quality than that on the true bedrock. It averages .901 in fineness. The company takes its water from Otter Creek through a ditch carrying 200 inches of water, which gives about 60 feet of pressure. There is about 6,000 feet of iron pipe—800 feet of 11-inch and 5,200 feet of 15-inch. The bedrock flume is in two sections; the upper is 3 feet wide and 1,200 feet long; the remainder is 30 inches wide and 1,440 feet long. Rock riffles are used in the bedrock flume and block riffles in the other. The dump is into Cañon Creek and Pine Hill Creek. The capping is lava.

GOLDEN STATE CLAIM.

On the opposite side of Cañon Creek from Jones Hill is the Golden State claim, working quartz seams in the slate bedrock by means of hand mortar and a few boxes. The veins course 400 feet east of north, and are followed through open cuts and small drifts in the harder slates. The work is carried on by the two owners. A panful of quartz washed out in the writer's presence yielded several dollars of coarse quartz gold.

At Greenwood, 5 miles west of Georgetown, is a seam mine worked like a hydraulic, known as the Nagler claim; and north of this the Bower Mine, which has yielded over $2,000,000. Where free water or cheap power of any kind can be procured, to use in connection with large crushing capacity, this kind of ground can well be worked with the aid of stamps, as the quartz seams in the porphyry belt are generally within an area 150 feet in width, and the ground can be broken very cheaply.

TAYLOR MINE.

About 3 miles to the southwest of Georgetown was the only large active quartz mine visited during the short time allotted to this section of country. It is known as the Taylor Mine, and is on the west side, on the course of the Mother Lode belt, near Coloma Cañon, in the black slate.

The vein in the Taylor Mine courses north 45° west, while in the Rosencrantz, adjoining, the direction of the vein is north 25° west. The dip is to the east about 60°. The vein, which averages about 20 feet in width, is opened by an incline on the foot wall, 500 feet deep. Levels are driven from the shaft at every 100 feet, extending at the first station 300 feet south and 200 feet north; at the 200-foot level the same distance south and 300 feet north; on the 400-foot and 500-foot levels the drifts have been extended only one way, 450 feet in the upper and 250 feet in the lower one. The whole of the work has been done in development and exploration; no stoping up to date. One pay shoot 400 feet long has been developed; the vein shows the peculiar black gouge of the Mother Lode. The quartz is free milling, carrying about three fourths of one per cent of sulphurets. Timber grows on the mine. Six-foot lagging is used, which costs 4 cents apiece. The mine is drained by electric pumps placed on the 200-foot and 500-foot levels, hoisting about 40 gallons per minute. The entire mill and mine plant is lighted by electricity, an eighty-light dynamo in the mill being run by the mill wheel.

The ore dumps directly into the ore bins of the mill; it is hoisted in iron skips carrying one ton to the load, with a double reel hoist and steel wire rope. The entire machinery is run by water power, with 60 inches of water taken from the California Canal Company's ditch, and delivered under a head of 400 feet onto two Pelton wheels—a 4-foot wheel at the mill and a 6-foot wheel for hoisting, etc.

The mill carries twenty stamps of 750 pounds weight, which make about one hundred and four drops per minute, and give a duty of from 3 to 3¼ tons per stamp, discharging through a No. 0 sheet-tinned screen. It is fed from the ore bins through Hendy Challenge feeders. The aprons are plated, 5x6 feet in size. Each battery discharges onto a Woodbury concentrator. None of the sulphurets have as yet been worked.

The works employ thirty-four men; of these, twenty-three work under ground and are paid $2 50 per day. The timber men are paid $3, and the mill men at the same rate.

VOLCANOVILLE.

This, at one time a prominent mining camp, is about 9 or 10 miles from Georgetown, to the east, but to reach it by the road following up the ridge, requires about 15 miles; it is in the center of the gravel workings. Immediately opposite, across the Middle Fork Cañon, are Forest City and Bath, about 3 miles distant. The serpentine belt, that passes to the east of Georgetown, passes Volcanoville on the west, and on the contact with the slate northwest of town carries a quartz vein, where the Josephine Mining Company had their works, but at present deserted.

Starting from Georgetown, the road flanks Hotchkiss Hill, crossing the serpentine belt for a distance of 2 miles. Beyond the serpentine

on the east are silicious slates, after crossing which the road runs on the lava belt to the north and west, till Volcanoville is reached.

It appears that more erosion has taken place on the Volcanoville side of the river cañon than on the Placer County side, yet gravel deposits are found all the way from Pilot Creek on the east, to beyond Greenwood on the west, along the northern slope of the Divide, ranging from 25 to 300 feet in depth, except where cut away by the present streams. It is the opinion of many who have been intimately connected with the working of these gravel deposits, that the present channel of Otter Creek was occupied, at one time, by one of the forks of the American River, and a bird's-eye view of the country would seem to justify the opinion. On the other hand, after observing the detached gravel deposits at Bottle Hill, Jones Hill, and Cement Hill, and the direction of the outcrop of the gravel channels at Forest City and Bath, on the north bank of the Middle Fork, it would appear as if the former drainage system in these parts was from northeast to southwest directly across the present streams. An intelligent understanding of the ancient channel systems on the Divide can only be arrived at by thorough surveys and comparisons of the bedrock levels; that such work, combined with more extended exploitations of the ground, would well repay the labor, can hardly be doubted.

Between the serpentine belt and the vein of the Josephine Mine, along the course of the talcose slate wall, the surface paid well for washing; the cañons in the vicinity yielded coarse quartz gold. Beyond the serpentine that forms the other wall are micaceous schists, with seams of a glassy, bluish quartz, but they have not been found rich enough to pay to work.

Evidences of a gravel channel under a heavy capping of cement are seen on the east side of the town, but have not been followed.

Northeast of Volcanoville, near Mount Gregory, in the old Hope Mine, the bowlders on the north side of the channel are principally lava, while on the south side they are all quartz. In the Worthington claim adjoining, with a bank 60 feet deep, the gravel from top to bottom pays 16 cents per cubic foot.

South of Volcanoville, at Grizzly Flat, are drift diggings on a former bed of Grizzly Creek; the cement capping here is 60 feet deep. The channel is from 15 to 25 feet wide, showing a northeast course, with from 2 to 3 feet of gravel, on a slate bedrock. The gold is of the coarse order, though no very big pieces have been found.

In one of the cuts to the south of the road, not far from Mount Gregory, the channel gravel next to the bedrock was composed of very large bowlders of slate and porphyry, entirely unwashed, with sharp sides and corners, mixed in with washed quartz gravel, covered with cement. One of the large bowlders was rounded, with one flat side that contained marks similar to striation scratches. Above this cement was a second deposit of regular quartz gravel wash, capped with lava, the whole bearing the appearance as if the lower strata had been the result of a break of the rim of an old channel situated on a higher level, over which, at a later period, a new channel had formed its bed.

Continuing along the ridge to the east is a stretch of country called the desert, overgrown with chaparral, that appears to be all gravel; beyond this the main granite is found.

The copper belt, which is seen in Tuolumne and Calaveras Counties,

to the west of the Mother Lode, is represented on the Divide in the same relative position. Owing to the limited time at the disposal of the writer, little more than a general review of a small portion of the Divide could be obtained.

MINERALOGICAL NOTES ON BROOKITE, OCTAHEDRITE, AND QUARTZ.

By George Frederick Kunz.

An interesting discovery of minerals was made at Placerville, El Dorado County, by Mr. James Blackiston, in a quartz ledge running north and south and dipping eastward about 45° to 50°. The rock of the ledge is partly decomposed and partly compact, and is traversed for perhaps a hundred feet by a vein of crystallized quartz, varying from 6 to 14 inches in width. This vein is also decomposed and filled in with a reddish earth and sand, and can be dug into with a stick or board.

Fig. 1.

It is full of quartz crystals, of all sizes, from that of a man's finger up to remarkable dimensions, some of them weighing as much as 80 or 90 pounds. Several of these, over 50 pounds in weight, were pellucid and free from flaws; while others have peculiar interest from remarkable inclusions of chlorite, 3 to 5 millimeters in thickness, at several depths in the crystal—thus marking successive stages of crystal growth, and

making very striking "phantoms," generally of green chlorite, or white quartz layers. Of still greater interest, however, are other quartz crystals, 2 to 4 inches long and half that amount in diameter (Fig. 1),

Fig. 2.

containing at and near their centers inclusions resembling groups or clusters of dolomite or siderite crystals, cream-white to brown in color, and consisting of many curved rhombohedra from 2 to 4 millimeters in diameter. On breaking the specimens, however, the curious fact appears that these groups are hollow cavities in the quartz, the spaces being lined with a layer of chalcedony, or when brown, occupied only by a brown silicious material. This would indicate that the original mineral must have been siderite or ankerite, afterward covered up by successive growths of the quartz, and in some manner decomposed during that process. The inclusions of green chlorite form interesting phantom crystals. (See Fig. 2.)

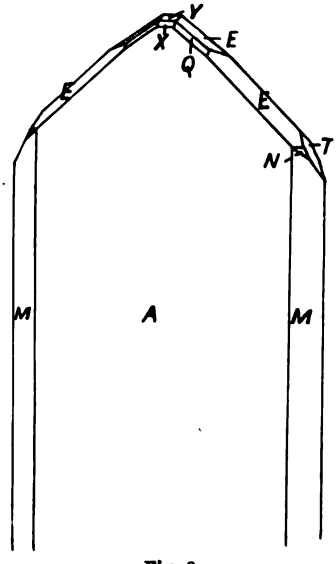


Fig. 3.

After receiving some of these specimens, the present writer detected a small crystal of octahedrite adhering to one of the small quartz crystals. Search was then instituted at the locality, which resulted in the dis-

covery of a number of crystals of both octahedrite and brookite, some loose and some attached to the quartz. The octahedrite is in splendid crystals, from 2 to 5 millimeters in length, and varying in color from brown to almost a dark blue. Their form is that of the unit pyramid, slightly distorted by horizontal striation.

The brookite is similarly implanted on the quartz, and partly or wholly overgrown by it, so as in some cases to be a true inclusion. The crystals are tabular, about 2 millimeters broad and one fourth of a millimeter in thickness. Their color is a rich reddish or yellowish brown, and they are free from inclusions. In form and association they closely resemble brookites from the Tyrol and from Maderananthal, Switzerland, lately described by P. Groth, von Zepharovich, and Zimányi. The following planes were kindly identified and the drawing (Fig. 3) made for me by Dr. S. L. Penfield, of Yale University:

a,	100,	$\bar{i}$-$\bar{i}$	*t*,	021,	2-$\bar{i}$	*n*,	121,	2-$\breve{2}$
c,	001,	*O*	*x*,	102,	$\frac{1}{2}$-$\bar{i}$	*e*,	134,	$\frac{3}{4}$-$\breve{3}$
l,	210,	$\bar{i}$-$\bar{2}$	*y*,	104,	$\frac{1}{4}$-$\bar{i}$	*Q*,	234,	$\frac{3}{4}$-$\breve{\frac{3}{2}}$
m,	110,	*I*	*e*,	122,	1-$\breve{2}$			

The faces were small, but gave him sufficiently distinct reflections for the identification of the forms; the pinacoid *a* is vertically striated. A distinct pleochroism was observed for vibrations parallel to *a* pale yellow, and parallel to *c* reddish yellow. Small crystals of an asparagus-green epidote, 2 centimeters long and 2 millimeters in diameter, were also observed partly inclosed in the crystals of quartz.

FRESNO COUNTY.

By W. L. WATTS, Assistant in the Field.

Besides possessing a large area of the most fertile valley lands of California, Fresno County is rich in almost all the minerals of the State. In her eastern mountains extensive bodies of ore, yielding both the precious and useful metals, have been discovered, and in some instances are profitably worked; while in the portion of the Coast Range included within her western borders, the more recent sedimentary formations furnish both coal and oil. In the valley lands the disintegrated constituents of the mountains on both sides have given to Fresno County a productive soil, and the method of their arrangement allows a supply of good water to be obtained at no great depth. Part of the water in the mountain streams flows in its natural channel, or is diverted for the purposes of irrigation, and part joins the subterranean flow, which silently and unobserved finds its way through the porous strata beneath the orchard and wheat fields of the valley lands; and when this undercurrent is tapped under suitable conditions it produces flowing wells.

The California State Mining Bureau takes pleasure in recording a new discovery in the valley lands of Fresno County, viz.: the inflammable gas, which was struck at a depth of a little more than 1,000 feet, about 7 miles north of White's Bridge.

FLOWING WELLS.

As far as experiment has yet demonstrated the area throughout which flowing wells can be obtained in Fresno County may be roughly outlined, on the northeast by an imaginary line commencing about 2 miles west of Minturn, and extending in a southeasterly direction to a point a few miles north of Riverdale, where it bends farther eastward toward Goshen, in Tulare County.

On the western side of the valley the boundary of the artesian area may be regarded with approximate accuracy as commencing at a point on the northern county line about 1 mile east of the San Joaquin and Kings River Canal, and extending in a southeasterly direction to Firebaugh's Ferry, where it would cross the canal and continue in a southeasterly direction parallel to, and probably about 4 miles west of Fresno Slough, to the Tulare County line.

It is possible that flowing water may be obtained still farther to the eastward, throughout districts subtending the principal streams.

Near the northern boundary of the county, within about 2 miles of the eastern bank of the San Joaquin River, a flowing well was obtained at a depth of about 300 feet, which flowed 3 inches above the casing.

On the New Columbia ranch, about 18 miles southwest of Madera, a well was bored and the following formation noted:

Sand	50 feet.
Clay	290 feet.
Sand	5 feet.
Blue clay	56 feet.
Sand and flowing water.	
Blue clay	9 feet.
Sand	4 feet.
Clay	4 feet.
Sand	1 foot.

The water in this well is brackish.

In April, 1886, a well was bored on the ranch of Miller & Lux, about 12 miles west of Borden, to a depth of 280 feet; flowing water was struck at 246 feet. The character of the formation is alternate strata of sand and clay, but mostly clay; the water flowed three quarters of an inch over a 7-inch casing.

Also, on the Miller & Lux ranch, a well was bored in June, 1886, about 6 miles north and 1½ miles east of the last mentioned well, to a depth of 250 feet. The formation is principally clay. Flowing water was struck at a depth of 200 feet, which flowed about half an inch over a 7-inch casing.

About 7 miles west and 3 miles north of this well a third well was bored on the same ranch, to a depth of 231 feet; the water flowed 3½ inches over a 7-inch casing. Only one flow was observed in this well. The strata penetrated were nearly all clay, one stratum of blue clay passed through being 55 feet in thickness, extending from the depth of 176 feet to that of 231 feet.

About 2 miles north of the third well, on the same ranch, a fourth well was bored in August, 1886, to a depth of 278 feet, which flowed 1¼ inches over a 7-inch casing.

About 6 miles west of Madera, on a ranch of Miller & Lux, a well, which was 234 feet in depth, and flowed a quarter of an inch over a 7-inch casing, was deepened to 633 feet. This increased the flow to three-quarters of an inch. Below 234 feet, alternate strata of light-colored clay and sand were penetrated, the thickest of which was only 40 feet, nearly all the others being less than 10 feet. The formation became much harder toward the bottom; all of the sandy strata yielded a little water.

On the western side of the San Joaquin, at Dos Palos, a well was bored several years ago; the formation is as follows:

Adobe	9 feet.
Sand	35 feet.
Blue clay	1 foot.
Sand	4 feet.
Gray clay	12 feet.
Sand	27 feet.
Blue clay	14 feet.
Sand	12 feet.
Blue clay	21 feet.
Sand	13 feet.
Blue clay	4 feet.
Sand	53 feet.
Blue clay	1 foot.
Sand, with flowing water	13 feet.
Clay	1 foot.
Sand, with flowing water	30 feet.
Blue clay	15 feet.
Sand	13 feet.

The water flowed 1½ inches over a 7-inch casing.

SHALLOW WELLS.

The city of Fresno is supplied with water pumped from eight wells within the city limits, the best head of water being struck at a depth of about 150 feet. An experiment was made at the waterworks on one well, which was 200 feet deep and 10 inches in diameter, by pumping with a Worthington pump, which had a capacity of 2,000,000 gallons in twenty-four hours. At first the water was somewhat lowered, but after pumping about half an hour, the water became stationary at a depth of about 12 feet from the surface; and although the pump was run at its greatest capacity for several hours, it failed to further lower the water. The temperature of the water in summer was found to be 73° F.

In Fresno and vicinity, wells are usually bored from 60 to 80 feet, at which depth an abundant supply of water can be obtained.

From diligent inquiry the following seems to be the general characteristics of the superficial formations throughout an area extending on the south beyond the county line, and bounded on the east by an imaginary line drawn parallel to the foothills and cutting Centerville, on the west by the Fresno Slough, and on the north by a sandy ridge about 2 miles north of Fresno. Throughout this area, on the eastern side of the S. P. R. R., the soil is generally either a reddish clay loam, from 3 to 4 feet deep, or a sandy loam from 4 to 6 feet in depth. Along the base of the eastern foothills there is what is locally known as a "dry bog land." This appears to be a kind of adobe, which cracks open in summer and forms a clayey bog in wet weather. There is also a "white ash land," which is a light-colored, pulverulent sandy loam, of variable depth, but seldom exceeding 5 feet. This lies mostly on the western side of the S. P. R. R., between the railroad and Fresno Slough. Beneath the surface soil is usually a hardpan of indurated sandy clay, varying in thickness from a few inches to several feet. There are two kinds of hardpan, a "red hardpan," which underlies the sandy and clay loam, sometimes passing into a clayey stratum, and a "white hardpan," which underlies the "white ash" land. Below the hardpan is a stratum of quicksand, from 6 to 10 feet in thickness; this holds a great deal of water in irrigated districts, but it is cased off. Beneath the quicksand is a white clay, from 10 to 20 feet thick, and beneath the clay a coarse sand with plenty of water. Beneath this is a blue or red clay, varying from 5 to 120 feet in thickness. The clay overlies a second stratum of coarse sand, from which a practically inexhaustible supply of water is obtained.

Some twenty years ago, before the land around Fresno was irrigated, the alluvial strata could be penetrated for 50 feet without obtaining water, but now the first water is struck within 13 or 14 feet of the surface. It has been observed in some places that the rise of the water plane has resulted in the hardpan being softened and formed into clay. Some loss has been experienced, especially in the "white ash districts," which are sub-irrigated, by the rise of efflorescent salts to the surface; this deteriorates the quality of the land and is prejudicial to plant life. The saline efflorescence appears to increase with continued sub-irrigation and the rise of the water plane.

In the foothills to the east of Centerville, water is obtained principally from springs.

Borings in the sandy ridge north of Fresno have shown:

Very sandy loam	10 feet.
Hardpan	2 feet.
Coarse sand	112 feet.
Cobblestones.	

A good supply of water was obtained at a depth of 20 feet.

Northward, from the sandy ridge before mentioned to the San Joaquin River, is the "hog-wallow country," and borings in this district have shown the following formation:

Red loam	1 to 2 feet.
Red hardpan	20 to 25 feet.
Coarse sand	30 to 40 feet.
A small amount of water is obtained toward the bottom of this stratum.	
Blue clay	10 feet.
Sand, with plenty of water.	

The water rises only a few feet in the casing, and deep pumps are used.

Around Borden surface water is generally struck at a depth of 20 to 30 feet, and a supply of good water is obtained at a depth of from 90 to 110 feet. The wells in this vicinity are deeper to the north and east and shallower toward the south and west.

Around Madera wells are usually bored to a depth of from 50 to 100 feet; and there is an abundant supply of surface water at a depth of from 12 to 18 feet. The variation in the depth of the wells results principally from the difficulty of finding a stratum sufficiently firm to make a good "landing" for the casing. The formation is:

Soil	4 to 20 feet.
Hardpan	2 to 8 feet.
Quicksand, with water.	

The water supply is practically inexhaustible.

Around Minturn the wells used for watering stock and at sheep camps are frequently only about 13 feet deep, and a sufficient supply for steam pumps can be obtained at a depth of from 35 to 45 feet.

Between Berenda and Minturn, on the Chowchilla ranch, about 3 miles west of the Southern Pacific Railroad, the water from a well 150 feet deep rose to within 3 feet of the surface of the ground.

To the westward, beyond the Fresno Slough, water is more difficult to obtain. At Lillis it is 14 feet to the surface water, which is generally brackish and hard.

From Lillis westward the rise in the surface of the ground toward the western foothills is about 7 feet to the mile, and the depth to the water plane increases proportionately, until at Huron it is 130 feet to the surface water, which is usually very hard. Still nearer to the hills the water plane is deeper and more variable, a depth of 150 to 200 feet being frequently attained before water is reached, and even then it is seldom good.

Fairly good water can usually be found in wells sunk in the creek beds, and in some instances in what appear to be beds of ancient creeks.

Some miles north from Huron, the wells are shallower, it being only 70 feet to water, but toward Cantua it again becomes deep, the formation being a tough, unctuous clay.

The top soil throughout these southwestern portions of Fresno County

varies from a sandy sediment to a clayey loam, beneath which is usually a very dry adobe; and well-borers state that it appears that the bottom and top moisture never come in contact.

The drift from the mountains is filling the valley very rapidly, but of course the drift is intermittent and irregular in its distribution.

Along the western borders of the slough, the wells are naturally shallower and the water better. Skirting the western foothills still farther northward as far as the county line, wells are deep and the water supply uncertain. Various borings have shown:

Surface soil	10 to 15 feet.
Reddish, unctuous clay	50 to 60 feet.
Coarse sand, with "alkali water."	
Red clay	200 to 250 feet.
Sand and frequently cobblestones.	

Sometimes a supply of water is obtained, and sometimes not.

THE MINARET IRON MINES.

These mines, which are deposits of both iron and silver ore, were prospected during 1891–92. The locations now made are as follows:

The Bay Field.
Fourth Magnetic.
Iron King of the Minarets.
Ironclad.
Fifth Magnetic.
The Ora.
Second Magnetic.
Second Bull of the Woods.
Fourth Iron King of the Minarets.
The Ogden.
Champion.
New York.
Second Magnetic Iron King of the Woods.
Iron King of the Minarets.
No. 6 Magnetic.
Mabel.
Thirteenth.
Second Jackass.
Third Jackass.
Magnetic.
Seventh Magnetic.
Sixth Magnetic Iron King.
Third Iron King of the World.
Seventh Iron King of the World.
Allen & Anderson.
No. 9 Magnetic.
The Reynolds.

These twenty-nine separate locations constitute the group of the Minaret Iron Mines; they are situated about 75 miles northeast from Fresno, near the Mono County line. This group of mines was discovered and located by C. J. Beck, about eleven years ago. An analysis of the ore was given in the Tenth Annual Report of the California State Mining Bureau.

Although these mines are located in the names of various parties, in 1891 they were consolidated under bonded contracts held by Messrs. Allen & Anderson, of Fresno City, who informed the writer that they were in correspondence with a syndicate in Europe with reference to purchasing and working the mines. The Minarets offer a practically inexhaustible supply of iron ore.

THE MINARET SILVER MINES.

These mines are situated in close proximity to the iron mines, and comprise the following claims:

The Bullion.
The Comstock.
The Sharp.
The Little Expositor
The Minnehaha.
The Mace.
The Basalt.
The Second Basalt.
The Third Basalt.
The Red Mountain.
The Gray Eagle.
The Second Red Mountain

IRON MOUNTAIN. SHOWING GOVERNMENT MONUMENT AND ICE GORGE.

U. S. MINERAL MONUMENT ON TOP OF IRON MOUNTAIN.

SOUTH SIDE IRON MOUNTAIN, SHOWING LEDGES OF IRON.
MINARET IRON MINES, FRESNO COUNTY.

The Lone Pine.
The Harslep.
The Robertson.
The Gold.
The Sierra.
The Hampton.
The Second Comstock.
The Great Eastern.
The Silver King of the Minaretas.

These mines were discovered and located by C. J. Beck, at the same time as were the iron mines. They are also consolidated under bonded contracts held by Messrs. Allen & Anderson, who are negotiating for their sale.

THE FINE GOLD MINES.

These mines were discovered and located about six years ago by Wm. Reed, of Fresno. They are situated in Fine Gold Gulch, about 1 mile north of the San Joaquin River, and about 35 miles east of Fresno City. They consist of three mines, viz.: The Henrietta, the Lottie K, and the Sarah Althea Terry.

The owners state that at the Henrietta Mine there are three tunnels, and that in all, about 300 feet of work has been done on the mine. The vein, which is about 3 feet in width, has a strike of northwest by southeast. The ore is free milling, and an experimental run of about 5 tons was made in an arrastra, which showed a clean up of $37 to the ton. The owners are W. E. Reed, Jas. Harris, T. J. Brennan, and N. L. Allen.

The Lottie K is a northwest extension of the vein on which the Henrietta is situated. At this mine there are four tunnels, and about 400 feet of work altogether has been done. The vein is about 3 feet in width, having a similar strike and dip to that observed in the Henrietta, and assays of the ore have shown similar returns.

The Sarah Althea Terry is a northwest extension of the Lottie K, and the vein presents similar characteristics to those observed in the Lottie K, except that the vein is only about 1½ feet in width. About 100 feet of work has been done on this mine.

The vein on which this group of mines is situated has been traced for more than 8,000 feet. The position of the vein is such that the mine can be worked by tunneling, and it affords good natural drainage. In the vicinity there is a plentiful growth of pine and oak.

THE THORNTON PLACER MINE.

This mine was discovered about four years ago. It is situated about 500 yards from the San Joaquin River, and about 200 feet above it. The claim has been worked by sliding the gravel down a chute to the river. The mine has been sold to the San Joaquin Mining Company, of Fresno, who are said to have taken out about $15,000 in gold dust during 1891.

THE HURON MINE.

This mine is situated in Aubray Valley, about 6 miles east of the old townsite of Millerton. On this mine two tunnels have been run, about 350 feet each; one shaft has been sunk to a depth of 210 feet, and several smaller shafts and levels have been made. There is a 5-foot Huntington mill on this property. This mill, which has a capacity of 18 tons per day, was run for about ten months, work being temporarily suspended in September, 1891. The ore is free milling and assays are said to have shown from $6 to $95 per ton.

THE STEVENSON & DINKLEY PLACER MINES.

These mines are situated at Dead Horse Creek, near the headwaters of the San Joaquin. Ground sluicing was carried on successfully at these mines during 1891, and it is said the miners made as high as $10 per man per day.

DRIFT MINING ON THE SAN JOAQUIN.

Tunnel and drift mining has been actively prosecuted on the San Joaquin River, about 2½ miles above Fine Gold Gulch. Twelve men were engaged during 1891–92 drifting and washing in sluice boxes. The gold is very fine, but the men are said to have made from $8 to $12 per man per day.

THE ZEBRA MINE.

This mine is now owned by a company who have their office in San José.

THE WATERLOO GOLD MINING COMPANY.

The mine operated by this company is situated about 5 miles from Coarse Gold, on the east side of Upper Fine Gold Gulch, about 18 miles east from Raymond. It adjoins the Last Chance Mine on the northwest, and consists of two claims, 3,000 feet by 600 feet. It is owned by an incorporated company. The course of the vein is northwest by southeast, and the dip northeast at an average angle of about 45°. The hanging wall is said to vary from quartzite to granite, and from that to slate, while the foot wall is always slate. Supplies are received from Raymond at a cost of 50 cents per hundred pounds. The workings consist of a tunnel 575 feet long, and 240 feet of drifts and crosscuts; there are also nine shafts, varying from 40 to 82 feet in depth. A shaft 82 feet deep connects with the tunnel, and through it ore is hoisted to the surface. The average width of the vein is about 8 feet of solid quartz, varying from 2 feet up to 20 feet or more. The ore is worked in a ten-stamp mill, which runs continually. The ore averages $16 in free gold, with 3 to 5 per cent of sulphurets.

The following statistics were kindly furnished by the Superintendent of the mine:

Cost of sinking	$4 00 per foot.
Cost of drifting	3 00 per foot.
Cost of mining ore	1 00 per ton.
Cost of milling and handling ore	2 00 per ton.
Cost of timbers	3 to 5 cents per running foot.
Four-foot cord wood	$2 50 per cord, delivered.
Lagging four feet long	4 cents each.
Number of men in mine	10.
Number of men in mill	4.
Number of men outside	2.
Average wages in mill	$2 75 per day and board.
Average wages in mine	2 00 per day and board.
Average wages outside	1 50 per day and board.
Length of ore shoots	Unknown at present.
Number of ore shoots	3.
Altitude of mine	2,500 feet.
Length of tunnel and drifts	815 feet.
Character of hanging wall	Quartzite, granite, and slate.
Character of foot wall	Slate.
Kind of powder used	Giant.
Number of feet of tunnel timbered	400 feet.
Kind of timber	Round oak and pine.

Character of ore	Quartz, with sulphurets of iron and galena.
Quantity of wood used	Two cords per twenty-four hours.
Kind of concentrators	Two Frue vanners.
Kind of ore feeders	Hinckley, Spiers & Hayes' patent.

THE LAST CHANCE MINE.

Mining operations at the Last Chance during 1891–92 were largely in the nature of development, and the mill was run as the ore accumulated. The mine has been worked to a point where capital is required to develop it.

THE KINGS RIVER CAÑON COPPER MINE.

This mine was relocated in 1891. It is situated in Sec. 11, T. 3 S., R. 31 E., M. D. M. The ledge on which this mine is situated is said to have a strike of north of west by south of east, and to have been traced for a distance of 6 miles; and a portion of it is said to traverse territory which will be embraced by the Yosemite Reservation. The ledge is said to be from 3 to 9 feet in width, and to be crossed by three other ledges from 3 to 4 feet in width. The writer is informed that assays of the ore have shown from 13 to 45 per cent of copper. The ore is a sulphide, and some specimens are said to have shown a high silver value.

THE SAN JOAQUIN VALLEY COAL COMPANY.

The mine belonging to this company has already been described in the Tenth Annual Report. Work was resumed on this property in September, 1891. A slope was sunk to a depth of 250 feet to strike the vein at a greater depth. Difficulties resulting from water necessitated crosscutting the slope and making a chamber to receive machinery for pumping. From the chamber a drift will be run in on the vein. The formation penetrated by these workings admirably illustrates the superficial disturbance which is so noticeable in many places in this vicinity. Although the true dip of the formation at this point is easterly at an angle of about 30°, the strata first penetrated by these workings dip to the southwest magnetic at an angle of about 35°. The result of this is, that were the outcrops alone to be studied, it would convey the idea that work had been commenced on an anticlinal axis. Such slides, which result from the superficial formations slipping on the clayey shales when the latter are saturated by percolating waters, no doubt account for what are obviously local superficial disturbances in this vicinity.

THE CALIFORNIA COAL MINE.

This mine, which is being operated by parties in Amador County, is situated about one mile eastward from the San Joaquin Coal Mine. Since the last report about 400 feet of tunnel has been run on the vein, and some 300 tons of coal per month have been taken therefrom. About fifteen men are employed.

When the mine was visited by the writer, the vein, which is a very regular one, showed a thickness of about 2½ feet in the breast of the workings. For a long distance in the tunnel the head wall is sandstone, and the foot wall a tough, light-colored clay. Near the end of the tunnel the head wall suddenly changes to a tough, dark-colored

clay, from which the writer obtained several fossils. Once before in the course of the tunnel, which is about 1,000 feet long, there was a sudden change in the head wall from sandstone to clay for a short distance. Only at one point is there any sign of displacement in the vein, which dips in an easterly direction at an angle of about 35°.

A specimen of coal from this mine was analyzed by Dr. W. D. Johnston, Chemist of the Bureau, and it showed as follows:

Moisture	11.25 per cent.
Volatile carbonaceous matter	48.50 per cent.
Fixed carbon	31.40 per cent.
Ash	8.85 per cent.
	100.00 per cent.

The writer made a collection of fossils at the California and at the San Joaquin Coal Mines. These fossils were examined by Dr. J. G. Cooper, who gives it as his opinion that they prove the coal measures at the California and the San Joaquin Coal Mines to be of similar geological age to the coal measures of Mount Diablo.

IRRIGATION.

During the years 1891–92, the Alta Irrigation District has practically completed its system of distributing canals. This district has an area of 130,000 acres, and about 400 miles of main and lateral canals. The main canal has a capacity of 1,300 cubic feet per second. A service of one miner's inch is allowed per acre, in wetting new land for the first time; afterwards less than half that quantity is considered to be sufficient.

The Sunset Irrigation District has been organized since our last report, and $2,000,000 of bonds have been voted.

The Fine Gold Land and Water Company was organized in 1891, the object being to divert water from the San Joaquin River, at a point about 5 miles above the town of Pollasky, the present terminus of the San Joaquin Valley Railroad.

NORTH FORK MINING DISTRICT OF FRESNO COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

This district is situated in the northeast corner of Fresno County, in the high Sierras, and has been included in the limits of the lately formed National Yosemite Park. It occupies parts of T. 3 and 4 S., R. 25 E., and T. 3 and 4 S., R. 26 E., in the extreme southeastern limit of the reservation. It was for the purpose of investigating its qualifications as a mining district that it was visited the past season.

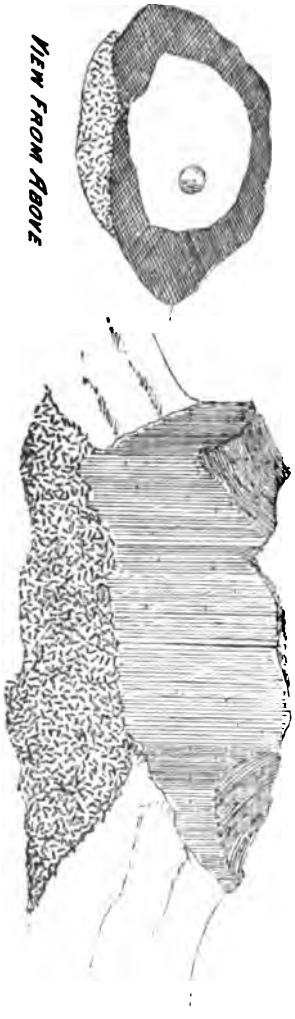
On leaving Fresno Flats, which lies 2,200 feet above the level of the sea, a northeasterly route is taken, crossing over a series of granite ridges, gradually increasing in height until the base of the main Sierra Nevada range is reached. All of this section is timbered with oaks of different varieties, including black, white, and live oak. The road crosses for about 4 miles over a country containing black slate, alternating with micaceous schists and gneiss, until, on further ascending the mountain, the granite domes and ridges become a conspicuous feature

of the landscape. From here into the North Fork the whole country gives unmistakable evidences of the former presence of large glacial flows. About 7 miles from Fresno Flats the grand pine forests of the western flank of the Sierra Nevada range are encountered, and from here the ascent is rapid. The first station made was at Soquel sawmills, situated in the midst of fine sugar pine timber. The mill has a capacity of 75,000 feet of lumber per day, and employs a large number of men. The lumber is conveyed through flumes to Madera. Six miles beyond are the Basaw Meadows, a grass-covered flat, at an altitude of 5,420 feet, from which the trail descends to the Chiquito Joaquin, which was crossed at an altitude of 5,375 feet.

Ascending the opposite bank of the cañon the trail crosses another extensive plateau for several miles, known as the Jackass Meadows. In the granite ridges that form the northwest boundary of these meadows there is some gold mining being conducted on small quartz veins, which are said to yield from $40 to $100 per ton; the rock is reduced in a small horse arrastra. Leaving this flat, a low divide is crossed leading to the Granite Meadows, which are nearly on the same level as the former, about 5,700 feet high. With a continued northeasterly course, the trail enters the cañon of the North Fork of the San Joaquin. Before descending, the very extensive view of the cañons of the high Sierras, as well as several of the isolated rounded granitic domes and some of the prominent peaks, is well worthy of notice. The view takes in the South Fork of the San Joaquin, also known as Fish Creek, as well as a part of the cañon of the main river, where they wind their way between the steep, bare granitic walls that have in former days been planed off by the ice. To reach the river where a ford crosses, a steep descent of over 800 feet has to be made, followed on the opposite side by an equally precipitous ascent, to an altitude of over 7,000 feet above sea-level. This is accomplished over a rough capping of eruptive rock. Again the trail crosses one of the numerous grassy flats which abound through this part of the mountains, to wind around and over a rough, rocky ridge, known as the "Granite Stairs." As its name indicates, the granite is broken up into regular blocks of stones, arranged somewhat amphitheatrically in rows one above the other, as if broken out by quarrymen. On attaining the summit of the ridge, the Minaret Peaks range in full view on the left hand, apparently only a mile or two distant, in reality 7 miles, while to the right the Pumice Ridge, and the summits of this part of the Sierra Nevada range, loom up in majestic grandeur. The altitude, as read by aneroid, is over 8,000 feet.

Descending, over an old lateral moraine, through Snow Cañon the Kings Creek crossing is reached, 6,425 feet above the sea. The distance from the top of the ridge to the crossing is 3 miles. We approach here the boundary of the North Fork Mining District, in the National Park. Following down Kings Creek to within 2 miles of its junction with the main San Joaquin River, a distance of several miles, after crossing another spur of the mountain, the main river is reached, which the trail follows up to the Soda Springs Meadows, so named from several very strong alkaline springs, containing a large percentage of gas. The last part of the distance the trail passes through patches of small white pumice a couple of feet deep, rendering travel either on foot or horseback extremely tedious. At the lower end of the meadows is one of the most remarkable basaltic columnar formations in the world; and in one of its

features unique, as far as the knowledge of the writer goes. Not being supplied with a kodak, the accompanying sketch was made, which conveys but a poor idea of this grand work of nature.



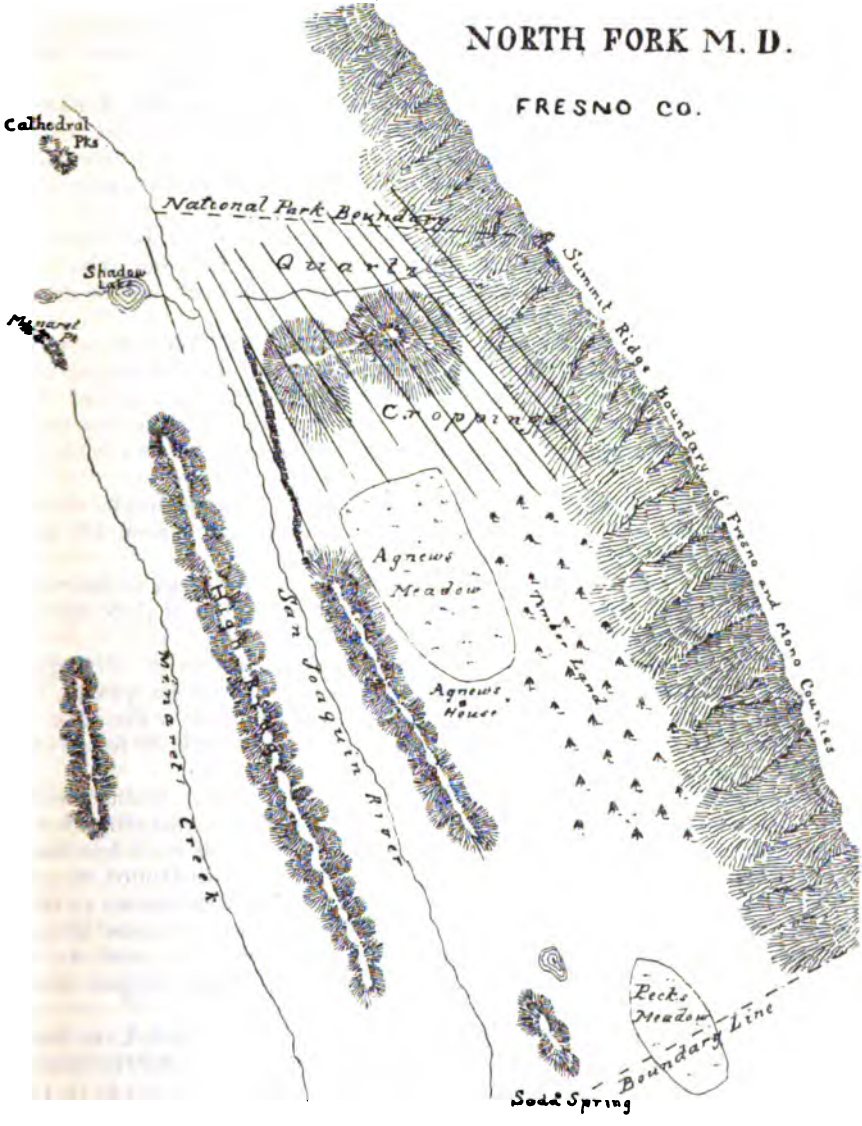
BASALTIC COLUMNS at SODA SPRINGS MEADOWS FRESNO. CO. CAL.

Facing the stream that passes down through the meadow, at the point where it leaves the same, is a basaltic bluff, about 50 feet in height, formed of a row of five-sided basaltic columns about 100 feet long, the center columns arranged as regularly as the pipes in a cathedral organ, while at the two ends the upper part of the columns are covered somewhat similar to a mansard roof. At the foot, along the entire front, is a talus of broken columns, reaching to a height of about 20 feet. Near the center, one of the columns has started to separate from the main mass, and stands upright and unsupported for the greater part of its height. A peculiarity in these columns is the fact that they are not cupped. Upon viewing the mass from above, the ends of the column, fitting tightly together, have been polished off smoothly by glacial action, giving the appearance of a parquetted polished floor. The interior of the bluff is hollow, crater-shaped, and filled with fine pumice, while near the center there is a small pumice cone 2 or 3 feet high. The west side of the flat is flanked by basalt that shows the columnar arrangement throughout. The altitude of Soda Springs is over 7,000 feet.

For 3 miles beyond the meadow, the trail passes over pumice-covered flats, on the other side of which metamorphic slate crops out, in which the first vein croppings of this part of the district are passed. The trail then flanks one of the numerous small lakes that are found around the base of the peaks throughout this section of country. About 6 miles from the Soda Springs Meadows is the homestead of Thos. Agnew, the Recorder, and one of the principal mine owners of the district. Numerous croppings are to be seen here, on which a number of locations have been made.

The district was organized as far back as June 17, 1878, and contains at the present time forty-seven bona fide locations that are entered on the Recorder's books, besides a few that have been recorded at the county seat, Fresno City. The bounds of the district, as given in the records, commences on a certain Red Mountain Peak, on the dividing

ridge between Mono and Fresno County, due east, about one mile from the Recorder's house, as marked on the township maps; thence 10 miles south, 10 miles west, 10 miles north, and 5 miles beyond to the before mentioned dividing ridge; thence along the divide to the place of beginning, comprising parts of four townships.



There are a series of croppings running nearly parallel with one another, but approaching as they bear to the northwest, having the same general strike as the divide, on the west flank of which they are partly situated. The croppings are very prominent, some of them of great width, the whole resembling a "gang-ug" (linked veins).

The following are the principal veins on the east side of the San Joaquin:

Mother Lode.—This shows the most prominently on the surface, but does not appear to carry as much ore along the greater part of its exposure as the rest. It is incased in slate about 60 feet in width; courses a few degrees north of northwest.

East of this about 600 feet is the *Homestake*, with 50 feet of croppings; has slate for one wall and quartzite for the other. A tunnel 80 feet long has been driven to cut the vein, which it has not yet reached.

Still following to the east, at a distance of 800 feet, is the *Advance*, 60 feet in width. A tunnel 100 feet long is being driven to cut across the vein, besides which there have been sunk two shafts of 10 feet and 24 feet, respectively, and several open cuts made in the croppings. The walls are slate and porphyry.

The *Silver Queen*, distant from the above about 200 feet, is 15 feet in width. It has been cut through near the mouth of a tunnel driven to cut the next ledge above. A 36-foot shaft has been sunk on the croppings; it is incased in black slate.

The *Fresno*, 200 feet to the east of the Silver Queen, is 75 feet wide, with slate and quartzite walls. It is being prospected by three tunnels, two of which are 330 feet and the third 100 feet in length. Ten feet of the vein has been crosscut; then the tunnels pass into vein matter, but none have reached the hanging wall. Several open cuts are at intervals on the croppings.

The *Mountain View* is the highest upon the flank of the divide, showing a width of 20 feet, and has been prospected with a tunnel 280 feet long and a 20-foot shaft.

The *Silver Streak*, from 15 to 20 feet wide, is the first vein to the west of the Mother Lode, from which it is separated by 360 feet of slate, which forms both walls of the vein.

The *De Soto*, 750 feet west, is a 50-foot vein with slate walls. Six open cuts have developed 1,400 feet of continuous mineral-bearing quartz.

Beyond this in the slate, which continues to the river, a distance of about 500 feet, there are two more veins: the *Black Jack*, 50 feet wide, and one without a name.

All of these croppings can be traced for several miles. Going north they are covered for quite a distance by an eruptive flow making down to the river across their strike. It is claimed that the De Soto has been traced along the croppings into the old Mammoth Mine, in Mono County.

The ores from all of these veins, as well as from those belonging in this district, but situated on the west bank of the San Joaquin, are silver-bearing quartz, carrying sulphides, carbonates, chlorides, as well as, to a limited extent, gold. Besides the precious metals, lead, copper, iron, and zinc, in combination, are contained in the ores.

It is stated by the Recorder that small parcels of ore which have been shipped for working tests have shown a yield of about $30 to $40 in silver, about 17 per cent lead, and $2 in gold. An average assay made in the State Mining Bureau from a sample of mixed ores from the different veins gave a higher result, both in silver and lead. Some samples from the west side veins showed a yield of 30 per cent copper and 27 ounces of silver. Assays as high as $800 per ton have been obtained from choice ore.

On the west side of the De Soto vein is a bluff that drops nearly per-

pendicularly 420 feet to the level of the river. To reach the claims on the west bank of the river it is necessary to turn back to the Soda Springs Meadows and follow up Minaret Creek, which empties into the main river just above the meadows. At first the trail follows along the basaltic rim in a northwesterly direction across some grassy flats; then rapidly ascending to an altitude of nearly 9,000 feet over a granitic ridge, skirts along the edge of Black Lake, a sheet of water at the foot of a high trap ridge, which is the source of Minaret Creek. This bluff, like so much of the surrounding country rock, shows glacier-polished surfaces. After passing over a rocky divide the descent is made to Shadow Lake, one of the main supplies of the headwaters of the San Joaquin River. At the foot of the Minaret and Cathedral Peaks is a smaller lake, known as Little Shadow Lake, which accumulates the drainage from the perpetual snow banks in the gorges of these high mountains, from whence it passes down over an old glacier bed into the main Shadow Lake, a body of water about a mile long and half a mile wide, the longer axis lying northwest and southeast, from which it passes through a rocky gorge not over 30 feet wide, over a series of falls into a rock-cut channel that empties into the main stream. The descent from the lake to the river-level is accomplished in a little over half a mile, the difference in the two water-levels exceeding 1,000 feet. The altitude at the west end of the lake is about 8,500 feet. The park boundary crosses from Sentinel Rock on the east line of the county over the ridge just north of the lake.

The croppings on the right or west bank of the San Joaquin are as bold and well defined as on the opposite side, taking the same course. The first two or three next to the river might be considered as belonging to the same system, but beyond that we have the veins in trap and lime formations. These carry a larger percentage of copper. They can be traced from the Copper Peaks and Minarets for several miles, and average from 30 to 40 feet in width.

The principal veins on the west side commencing from the river are the Big Blue Vein, Emma Nevada, and Nonpareil, each 60 feet wide; the El Dorado, Great Bear, Grand View, Clarion, and the Madera and Mint—the latter 100 feet wide.

These parts of the Sierra Nevada range bear evidence, in their granites and schists, that comprise the greater part of the general county rock, of great age. In the eruptive rocks two distinct periods are marked, the one antedating the glacial period, the other comparatively quite recent. The district appears to be in the line of the mineralized zone, extending from Mount Davidson, in Nevada, down to Cerro Gordo, in Inyo County. Notwithstanding the number of locations, owing to the lateness of the season, but one miner was in the district, the Recorder, to whom the writer is greatly indebted for information concerning the mines, as also for other courtesies. The whole region is well timbered and watered, but sadly deficient in roads.

GLENN COUNTY.

By W. L. WATTS, Assistant in the Field.

In this county the attention of the writer was principally confined to the water-bearing formations of the valley lands, and an inquiry as to the occurrence of natural gas in any wells which have been bored. It is interesting to note that the brine-yielding formations described in Colusa extend along the western foothills of Glenn County.

WATER, FLOWING WELLS, ETC.

The only flowing well that has been obtained in Glenn County up to the date of the writer's visit, in 1891, with the exception of a few springs which have been struck in shallow wells near the foothills, is the one upon the Rideout ranch, about 2 miles north from Norman. The formation penetrated is as follows:

Soil and yellow clay	337 feet.
Hard, dry sand	8 feet.
Fine sand	3 feet.
Hard, dry sand	8 feet.
Clay	30 feet.
Hard, dry sand	2 feet.
Clay and sand	20 feet.
Hard, dry sand	10 feet.
White clay	9 feet.
Sand	6 feet.
Hard, dry sand	9 feet.
Yellow clay	100 feet.
Alternate strata, about 2 feet thick, of clay and sand	299 feet.
Blue clay	20 feet
Sand and gravel	15 feet.
Sand, with flowing water	10 feet.
Hardpan	5 feet.
Blue clay	34 feet.
Quicksand	15 feet.
Total depth	940 feet.

This well yields about 6,000 gallons in twenty-four hours from a 2-inch pipe at a height of 15 inches above the surface of the ground. A small amount of gas was observed in this well, but when visited by the writer it had ceased, or had been cased off. This well is situated in Sec. 10, T. 18 N., R. 3 W., M. D. M.

Another was bored to a similar depth on the same ranch, in Sec. 26, T. 18 N., R. 3 W., M. D. M., the only difference noted being that similar strata were penetrated at an increased depth of about 160 feet. The direction of the second from the first well is southeast, and the distance apart 2½ miles. A small amount of gas was also observed in the second well, but the water only stood at the surface of the ground. The water in both wells is fresh.

In the first well the gas was observed at a depth of about 337 feet, nd in the second at about 500 feet.

SHALLOW WELLS.

Around Willows a good supply of water is obtained from dug wells at a depth of 18 feet, and from bored wells at a depth of 40 feet. The waterworks at Willows, the county seat, obtain their supply from a well 220 feet in depth.

In the town, and in the vicinity of Willows, the following formation has been observed:

Soil	4 to 6 feet.
Yellow clay	10 to 12 feet.
Gravel	4 to 6 feet.
Yellow clay	60 to 70 feet.
Gravel	20 feet.

From Willows eastward toward the Sacramento River, a similar formation prevails. Toward the northern part of the county more gravel is met with, the pebbles it contains varying from the size of a goose egg downward. Each stratum of gravel contains a supply of water, and the supply from the second and lower strata is practically inexhaustible. From the second stratum of gravel the water rises from 4 to 6 feet.

Toward Orland, bowlders are encountered within 18 feet of the surface, in a stratum of about 20 feet in thickness, mixed with sand, fine gravel, and clay. A supply of water is obtained in the sand and gravel.

Toward the hills the alluvium is from 6 to 40 feet in thickness, and the water is found on the bedrock. In some places there is good water at 30 feet, in others the rock may be penetrated 300 feet without getting a good supply.

Both around Germantown and south from Maxwell to the county line, it is about 100 feet to the second water.

BRINE SPRINGS AND WELLS.

Brine was struck on the ranch of Jeff. Garnette, about 17 miles west from Willows, at a depth of about 60 feet. There are also said to be some brine springs at a point about 3 miles west from Elk Creek.

GAS OR AIR IN WELLS NEAR GERMANTOWN.

In a well upon the Jacobs ranch, about 6 miles northwest from Germantown, the following formation was penetrated:

Soil	3 feet.
Red clay (water)	100 feet.
Hard white rock (water)	2 feet.
White clay, which became harder as the depth increased (water)	20 feet.

At the completion of this well, the water in the casing stood within 80 feet of the surface of the ground.

From strata penetrated by this well, a current of what is believed to be air issues previous to bad weather, and a current is drawn into the well as fine weather approaches.

Mr. Jacobs says that previous to a long period of stormy weather, a current of air will sometimes escape from the well for a week, or longer; but as soon as the direction of the current of air changes and is drawn into the well, it is a sure sign that the storm is about to cease. At first only the outgoing current was noticed; and in order to determine whether

it was inflammable gas which was escaping, attempts were made to ignite it, but without success. When the locality was visited by the writer, the wells were closed with pumps in them, which prevented the possibility of a near inspection, but the rushing sound was distinctly audible. The water in the well is fresh.

THE SOUTH SIDE IRRIGATION COMPANY.

This company have their headquarters in Orland, and divert water from Stony Creek. They intend to extend their irrigation works as far south as Greenwood, at which point a gravelly ridge obstructs the grade. Work was temporarily suspended by this company in the winter of 1890.

THE CENTRAL IRRIGATION COMPANY.

This company was organized at Maxwell under the Wright Act. They divert water from the Sacramento River, at the northeast corner of Glenn County. Their system extends through Glenn and a large portion of Colusa County.

HUMBOLDT COUNTY.

By W. L. Watts, Assistant in the Field.

The most important items of mineralogical interest in Humboldt County which have come under the observation of the California State Mining Bureau since the last report was issued are: The discovery of a good grade of lignite on Maple Creek; the investigations which have been made with regard to the extension of petroleum-bearing rocks in a southeasterly direction from Petrolia; the increased interest in placer mining at the Klamath River and on the seashore, and the discovery of auriferous veins in the southern portion of the county.

Small veins of coal have, from time to time, been discovered in various parts of Humboldt County, but the vein now opened on the Preston ranch, at Maple Creek, is the most promising yet noticed by the department. From geological observations at Boulder and Maple Creeks, it appears that the Maple Creek lignite is probably of the Pliocene age.

In 1891 the writer traversed a meandering route through the southwest portion of Humboldt County, after visiting Maple Creek; he followed the shore line to the Klamath River.

Throughout the portion of Humboldt County visited by the writer the Pliocene formation is well represented, either resting on the unaltered Miocene, as the line of petroleum-bearing rocks traced from Petrolia to a point on the county line southeast from Garberville would indicate, or on metamorphic rocks, as seen at Garberville and Boulder Creek, where the Pliocene is found resting unconformably on altered shale and sandstone.

It is quite likely that bituminous strata may be found in other portions of the county than those through which the line was traced between Petrolia and Garberville; especially farther inland, beyond the Pliocene formation. It is also not impossible that the Pliocene rocks might yield petroleum in some places, for in California the line of demarkation between the Miocene and Pliocene is frequently ill-defined.

The occurrence of auriferous veins in the southern portion of the county is very interesting; the ore, however, appears to be low grade.

A new impetus has been given to placer mining on the Klamath River.

On the seashore the sands of the Big Lagoon seem to offer a promising field for a gold-saving proposition, based on the principle of handling many tons an hour at a cheap rate. Gold washing is still prosecuted at the Lower Gold Bluffs and at Johnson's.

As is well known, the Gold Bluffs of Humboldt County have been a source of gold for many years, black sand having been obtained on the seashore there which, it is said, has in some instances shown several hundred dollars to the ton. Alterations in the contour of the coast-line have, however, deteriorated beach mining there of late years. Thus at one point, a little south of the mouth of Osagon Creek, the beach in 1860 could be passed only at low water, but there is now more than a quarter

of a mile of sand between the cliffs and low-tide mark, which is seldom if ever entirely covered by the waves. Formerly there was deep water but a short distance from the shore, and the tide washed the sand clean to the bedrock. The beach was quite steep, sometimes being covered with large pebbles, and at other times with sand; and it was on the sloping shore that the "panning surfs" concentrated the auriferous black sand. The shore-line at low water is now a nearly level stretch of reddish brown sand from Osagon to Gate Point, and some portions of it appear to be permanently above the reach of the waves. Shoal water extends for some distance out to sea, and a sandbar, which was first observed to be forming twelve or fourteen years ago at Osagon Point, stretches in a southerly direction parallel to the coast, reaching apparently nearly to Gate Point. The rapidity of this change, in the absence of other explanation, at once refers its cause to tidal action, rather than to secular terrestrial movement. A prevalence of westerly winds would, in the first instance, account for an accumulation of sand upon the beach.

At Gold Bluffs there are two kinds of surfs, known locally as the "straight in surf" and the "panning surf." The "straight in surf" occurs when the wind is from the west; this surf accumulates the sand upon the shore. The "panning surf" occurs when the wind is in the northwest or southwest; this surf exercises a panning motion, which "pans down" the sand, and removes the lighter particles where the beach is not too flat. This panning motion is the most effectual when the wind is in the northwest.

COAL.

The following specimens of lignite were obtained by the writer in different parts of Humboldt County. They were analyzed by Dr. W. D. Johnston, Chemist of the Bureau, and a comparison of their respective values as fuel is not without interest:

	Moisture—Per Cent.	Volatile Carbonaceous Matter—Per Cent.	Fixed Carbon—Per Cent.	Ash—Per Cent.
Maple Creek	16.25	44.50	31.50	7.75
Jacoby Creek	15.50	45.00	31.85	7.65
Glendale	14.00	40.75	29.50	15.75
Peaty matter, from Depuy's brick yard, Eureka	13.50	35.25	24.50	26.75
Peaty matter, from Clark's ranch, Eureka	12.50	40.50	22.50	24.50

The most important coal vein yet opened in Humboldt County is that known as the Maple Creek Coal Mine, which is situated on the Preston ranch, in Secs. 29 and 23, T. 5 N., R. 3 E., Humboldt meridian. This mine was discovered eight or nine years ago and entered as coal land, as noted in the Seventh Annual Report of the California State Mining Bureau. The development at this mine when visited by the writer in 1891, consisted of an incline some 30 feet deep, which showed two veins of lignite, one being a little more than 4 and the other about 1 foot in thickness. The hanging wall is a tough, light-colored clay, and the foot wall a light-colored, gritty clay, containing numerous small pebbles. Associated with the lignite were observed numerous exogenous stems, in

which the rings of growth were very distinctly marked. The manager of the mine informed the writer that in September, 1891, an experimental boring was made at the bottom of the incline, to the depth of about 60 feet, and that six seams of coal were passed through, varying from 5 to 16 inches in thickness, being separated by strata of clay. The dip of the formation is to the east of north. Several croppings of lignite have been discovered in the vicinity, and some prospect work has been done. A sample of this coal sent to the laboratory of the Mining Bureau showed:

Fixed carbon	28.8 per cent.
Volatile carbonaceous matter	41.9 per cent.
Ash (clay)	5.3 per cent.
Water	24.0 per cent.
	100.0 per cent.

A sample of coal was obtained by the writer from the Maple Creek Coal Mine, and an analysis of it made by W. D. Johnston, Chemist of the California State Mining Bureau, showed it to have a fuel value as previously noted.

A small seam of lignite also crops out on the Moore ranch, about 2 miles from the Maple Creek Mine, the dip being east of north at an angle of about 15°.

Coal croppings have also been observed in T. 4 S., R. 3 E., H. M., by Deputy Assessor C. B. Frost, of Eel River. The veins are usually only a few inches thick, but at one place there is a vein of more than 1 foot, from which a mass of "good lignite, weighing about 100 pounds," was taken out.

Coal croppings also occur on the east branch of the South Fork of Eel River, on the Rice & Renick ranch, where some coal was formerly mined and used in a blacksmith shop. Some portions of Secs. 3 and 4, T. 5 S., R. 4 E., H. M., are located under the Coal Act.

Coal croppings are also reported in Sec. 26, T. 4 S., R. 4 E., H. M., and small veins are said to crop out in the banks of several creeks running into the east branch of the South Fork of Eel River.

On the ranch of J. D. Depuy, in the southeastern outskirts of Eureka, a body of peaty matter, strongly resembling the deep turf of Europe, was exposed while digging clay for a brickyard, and the peaty matter was utilized for burning the bricks. The formation penetrated is as follows:

Sandy loam, varying in thickness from	5 to 20 feet.
Decomposed wood and peaty matter	18 ins.
This contained the trunks, apparently, of cedar trees, the wood of which was sound, some of them protruding through the sandy loam above.	
Blue clay	4 feet.
Peaty matter and lignite	1 foot.
Blue clay	5 feet.
Clay, containing shells	12 to 14 ins.
These shells were identified by Dr. J. G. Cooper as *Macoma nasuta* and *Ostrea lurida*.	
Blue clay	25 feet.

There is a similar deposit of peaty matter, containing partially lignitized wood, upon the Clark ranch, in the southern outskirts of Eureka. The peaty matter at this point is 4 or 5 feet in thickness. The formation appears to be nearly horizontal. The peaty matter is underlaid by clay, and is covered with earth.

A similar deposit, several feet in thickness, is said to have been found

on the west bank of Ryan Slough, several miles southeast from Eureka. There are also several other places in Humboldt County where small veins of coal have been discovered, as noted in the Seventh Annual Report of the State Mineralogist, for the year ending October 1, 1887.

A few years ago, when the Big Lagoon, on the seashore north of Trinidad, was partially drained by the sea breaking through the sandbar which separates it from the ocean, a large amount of peat is said to have been exposed; and at the time of the writer's visit, fragments of peaty matter could still be picked up on the shore off the lagoon.

Lignite has also been found at Jacoby Creek and at Glendale. Samples of lignite from these places were analyzed by Dr. Johnston, of the California State Mining Bureau, and their value as fuel can be seen by referring to the analysis previously mentioned in this article.

GOLD AND SILVER.

The Consolidated Mine.—This mine is situated on Salmon Creek, on the Scott sheep range, about 10 miles northwest of Phillipsville. It was discovered in 1890, and work was commenced thereon. This mine is owned by J. Scott, C. Carr, and others. The ore contains a large amount of iron pyrites. Assays of the croppings are said to have shown $4 in silver and 75 cents in gold to the ton. The vein was at first only 10 inches wide, but at a depth of 30 feet it increased to 12 feet in width. There are several other mines located in the vicinity.

The Jenks Mine.—This claim is situated about 10 miles northeast from Garberville, on the Jenks ranch, in T. 4 S., R. 4 E., H. M. The ore shows iron pyrites with a gangue of quartz and lime; it is said to assay from $9 to $12 per ton. Some prospect working has been done on this claim.

The New River District.—Some activity is reported in hydraulic mining on the Klamath River, below the Hoopa Reservation. Mr. A. B. Campbell, who at the time of the writer's visit to the county was operating the Mowrick Hill Mine, states that during the winter of 1890–91, the claims worked and the men employed at the district were as follows: At the Mowrick Hill, two men were employed; at the claim of W. Young, eight men; at the Orcutt claim, at Capell Bar, six or seven men. The Mowrick Hill Mine is a new claim, and is owned by A. B. Campbell, R. W. Miller, and parties in Sonoma County. It is situated on the north bank of the Klamath River, about 8 miles above Klamath Bluffs. Prospect work has been carried on at this point for many years, and it is said to be a rare thing to get a pan of gravel without a large, bright "color." Mr. Campbell states that the gravel is in three benches, about 300 feet deep in each bench. The gravel is interstratified with shale. The top of the gravel is about 2,500 feet above the present level of the river. The company now working these gravels obtains water from Capell Creek, which is said to run about 700 inches during the summer. The company constructed a new ditch in 1891.

GOLD SAND AT THE BIG LAGOON.

Gold was discovered in the sands of the Big Lagoon early in the 50's. It has been worked spasmodically ever since in a crude way, by rocker, tom, and sluice, and it is said that these methods have yielded about 90 cents a day to the man. It has also been the experimental ground for several gold-saving machines, as hereinafter mentioned.

The Big Lagoon is a lake of brackish water, about 3½ miles long by 2½ wide. It is separated from the ocean by a sandbar, averaging probably from a quarter to half a mile in width. The lagoon is fed by Maple and Pitcher Creeks. The depth of the lagoon is from 28 to 32 feet. During the summer there is no perceptible outlet to the ocean, but there is, no doubt, a great seepage through the sandbar.

Mr. T. H. Griffin, who has for the last four years protected the bar, states that gold is found throughout all the sand forming the bar, and that borings made by a sand pump to a depth of 16 feet showed coarser gold than that on the surface. Mr. Griffin further states that repeated experiments on the surface of the bar have shown that the sand will average from 12½ to 20 cents a ton, and sand from 16 feet below the surface has shown as high as 75 cents a ton. The bar appears to be increasing on its seaward side, having, it is said, gained from 50 to 100 feet in width during the last four years, and it is reported that the new sand appears to be as rich as the old.

The sandbar is Government property. The bar does not appear to grow on the side nearest the lagoon, the waters of Maple and Pitcher Creeks being clean, and bringing down but little detritus.

This Maple Creek must not be confounded with the Maple Creek previously mentioned in connection with the coal mines; the former rises in T. 8 N., R. 2 E., H. M., on the divide between Redwood Creek and Little River.

The sand of the Big Lagoon, unlike most of the auriferous sands of the California coast, contains but little black iron sand. Occasionally a "panning surf" concentrates the auriferous sand. Such a deposit of rich sand was once observed at Big Lagoon by Mr. Swann, of Orick Post Office, and he packed several tons of it above high-water mark. On the second day the tide so mixed the rich with the poorer sand as to render it unprofitable. Mr. Swann obtained $180 by washing the rich sand which he had gathered.

From what the writer can learn the following appear to be the more recent attempts to work the sands of the Big Lagoon:

In November, 1890, Messrs. Blodgett and Stillall made a run of sixteen hours with a single-pan machine, two men being employed, and it is said that they cleaned up $9 45.

In February, 1891, S. H. Robinson, of Oakland, experimented with a machine for four days, three men being employed. Their work was much impeded by the small capacity of their pump, which furnished water from the lagoon. It is said they cleaned up about $16.

In July, 1891, Mr. Pine, of Eureka, experimented with a machine of his own manufacture; he employed three men, and it is stated that in twenty-five days they cleaned up $80. They obtained water from a small creek, which is said not to have afforded a sufficient quantity to run their machine to advantage.

The writer washed several pans of sand at various places on the bar. Nearly every pan showed several "colors," but they were very fine and light. The gold was bright.

From the foregoing, it appears a vast amount of low-grade, auriferous sand exists at the Big Lagoon. The brightness of the color, although they are light, shows that there is nothing to prevent the gold being saved by ordinary processes. It would seem, therefore, that attempts to work the sand should be in the direction of handling many tons an hour rather than by refinement of mechanism to save the gold.

Cuttings that have been made into the sandbar have shown alternate layers of fine and coarse sand and small pebbles; at a depth of from 14 to 16 feet, mud is struck. The fine sand is the richest.

Prospecting on Maple Creek and the adjacent smaller streams has shown auriferous gravels, and from Maple Creek a piece of gold worth 20 cents was obtained.

A well dug to the depth of 15 feet at Mr. Griffin's home, on the southeast side of the lagoon, gives a good idea of the superficial formation of the main land. The formation penetrated was found to be as follows:

Sandy loam	4 feet.
Yellow clay	4 feet.
Whitish gray sand	5 feet.
Gravel, with a good supply of water.	

This gravel is auriferous, and a shovelful, which was "washed out," yielded nineteen small colors.

BEACH WASHING AT THE MOUTH OF REDWOOD CREEK.

Mr. Swann, of Orick Post Office, near the mouth of Redwood Creek, has at intervals for the last twenty years carried on "beach washing" to the north of Redwood Creek. From time to time, he scraped up the superficial accumulations of black sand left by the receding tide, and packed it beyond high tide mark to be washed at leisure; for water was to be obtained during the winter season only. Mr. Swann is of the opinion that the sand paid all the way from $3 to $16 a ton. The largest accumulations of black sand are when the wind is from the northwest.

BEACH WASHING AT THE LOWER GOLD BLUFFS.

The Lower Gold Bluffs belong to Messrs. Chapman & Greenbaum of San Francisco, and their property extends from Gate Point to the southern boundary of the Adams property, at the Upper Gold Bluffs.

At the Lower Gold Bluffs, besides the black sand, which accumulates to some extent on the shore below high tide mark, a sandbar, said to contain much auriferous sand, extends over an area of some 40 or 50 acres between the ocean and a small lagoon. This bar has been worked for many years.

During the summer of 1891, Mr. E. Ellis employed two men for about two months, and he appears to be well satisfied with the results. The method of washing employed by both Mr. Swann and Mr. Ellis was that of tom and amalgamating plates.

THE UPPER GOLD BLUFFS.

No work was in progress when the writer visited this interesting locality.

GOLD WASHING AT THE JOHNSON RANCH.

At the Johnson ranch, about 6 miles north of Upper Gold Bluffs, four men, during 1891, found remunerative employment with tom and sluice at the mouth of Amyny Creek. This claim has been worked for many years; it belongs to Mr. Johnson, and comprises some 60 acres. Besides the beach washing, the claim carries a deposit of auriferous gravel. It is the intention of Mr. Johnson to commence hydraulic mining as soon as he can obtain the necessary machinery.

SUNSET OIL WELLS AND ASPHALTUM REFINERY (LOOKING NORTH), EAST SLOPE OF COAST RANGE, KERN COUNTY.

SUNSET OIL WELLS, SHOWING FIVE OF THE SEVEN WELLS, WHICH ARE ALL PUMPED FROM THE PUMPING STATION IN BACKGROUND OF PICTURE.
Photo. by W. L. Watts, Field Assistant.

KERN COUNTY.

By W. L. WATTS, Assistant in the Field.

In this county the attention of the writer was directed mainly to the valley lands and the neighboring foothills.

Inquiry shows that in Kern County the central parts of the San Joaquin Valley are remarkably well supplied with subterranean water, and that this supply, as hereinafter shown, has been greatly increased of late years by irrigation. Throughout this valley, the territory adjacent to the Coast Range is by no means as well watered as the eastern side, and these conditions seem to be intensified in Kern County.

From correspondence with the owners of some of the principal gold and silver mines, it appears that mining in this county is in no respect a dead letter. Hitherto the rich ores have engrossed the attention of the miners, but with the advent of capital there is no doubt but that the low-grade ores will be profitably worked.

The restricted dimensions of this report necessitate the omission of the writer's investigations with regard to the oil and gas yielding formations of Kern County.

SULPHUR AND GYPSUM.

The sulphur deposits on the eastern side of the valley in Kern County occur principally as superficial beds, and in many places they are covered with drift from the mountains, with which the sulphur is frequently mixed. The sulphur sometimes rests on a bed of kaolinite and clay, and sometimes on gypsum, more or less mixed with earth; bituminous matter is often associated with the sulphur. The sulphur ore varies in quality from nearly pure, grayish, amorphous sulphur to rock permeated with sulphur crystals, or pebbles and drift cemented with sulphur. In some places sulphur has been penetrated for from 8 to 10 feet. At one point, where prospectors were at work, a fissure, varying from a foot to a few inches in width, was struck, which was lined with sulphur. The writer was informed that similar fissures had been encountered in the vicinity, and that when first struck they gave forth a strong flow of pungent gas.

On the claim of Frank Koskmyre, a hole some 6 or 8 feet in depth shows sulphur mixed with earth and drift from the mountain. This claim, which comprises about 20 acres, is in the N.W. ¼ of Sec. 28, T. 11 N., R. 23 W., S. B. M. There are also similar claims in this vicinity belonging to H. Ramey, Mrs. E. R. Hambleton, and others.

The gypsum beds, which appear to vary a great deal in purity, are the thickest a mile or so southeast from the Sunset refinery. In some places these beds attain a thickness of more than 20 feet, but none of them have been sufficiently developed to determine their average thickness or extent. Associated with the gypsum is much carbonate of lime.

FLOWING WELLS.

As Kern County is entered from Tulare, the area within which flowing wells have been obtained diverges from the main line of the S. P. R. R., forming a curve to the westward, until, between Poso and Lerdo, its eastern limit is some 10 miles westward of the main line of the S. P. R. R.

On the western side of the valley the writer could not learn of any flowing wells at a greater distance than about a mile to the westward from Goose Lake. It is quite probable, however, that artesian wells could be obtained anywhere in the swamp land betwen Goose and Tulare Lakes.

One of the strongest flowing wells on record in this part of the country was bored in 1889, on George A. Raymond's ranch, about 13 miles west and 3 miles south of Delano. The formation is alternate strata of sand and clay. There were nine flows of water in this well, the first being struck between the depths of 312 and 315 feet. The total flow was about 30 inches above an 8-inch casing. No gas was observed in this well.

In February, 1890, a well was bored on the ranch of H. Miller, 6 or 8 miles south of the county line, and south of Tulare Lake. Flowing water was struck at a depth of 650 feet. Eleven different flows were obtained, and altogether they flowed 3½ inches over an 8-inch casing. The depth of the well is 824 feet. No gas was observed in this well.

About 9 miles southeast of Delano, on the Burdette & Herbert ranch, a well was bored to the depth of 995 feet, which flowed 5 inches over a 9-inch casing.

On the Kitchen ranch, about 20 miles southwest from Poso, a well was bored in 1891 to a depth of 525 feet, which flowed 4½ inches over an 8-inch casing. The formation as shown by boring is:

Red loam	11 feet.
Dry white sand	17 feet.
Yellow clay	10 feet.
Surface water.	
Yellow clay	194 feet.
At this depth the water rose 1½ inches over an 8-inch casing.	
Yellow clay	15 feet.
Sand	85 feet.
At this depth the water increased to 2 inches.	
Yellow clay	96 feet.
Sand	20 feet.
At this depth the flow of water increased to 2½ inches.	
Clay	120 feet.
Sand	2 feet.
At this depth the flow of water increased to 3½ inches.	
Blue clay	18 feet.
Blue sand	7 feet.
Depth of well	595 feet.
At this depth the flow of water was 4½ inches over an 8-inch casing.	

There are numerous flowing wells in the center of the valley at this end of the county, but as they present a great similarity, the above will suffice to give an idea of the character of the filling of this portion of the valley, and the volume of water that can be obtained by boring.

In a southeasterly direction from Goose Lake the ground rises at a grade of about one foot to the mile, and it is not until Buena Vista Lake is approached that, as far as the writer could learn, there are any

flowing wells, although there is but little doubt that such wells could be obtained.

It is reasonable to conclude that the artesian area extends through the valley in a southeasterly direction, passing about 2 miles to the westward of the McClung and Panama ranches, and extending a short distance to the southeast of Adobe Station.

In this southern portion of the artesian area there are numerous flowing wells on the territory of the Kern County Land Company, and their depth varies from 300 to 1,100 feet. Flowing water is usually struck between the depth of 300 and 500 feet.

It is quite likely that deeper borings between Bakersfield, Adobe Station, and the Panama ranch might yield flowing water; for there is no doubt that a large portion of the Kern River sinks in the sandy formations through which it passes between Bakersfield and the eastern foothills.

FLOWING WELLS IN THE MOJAVE.

In 1891 some borings were made at Rodgers, about 20 miles east of the Mojave Station. A small amount of water was obtained at a depth of 50 feet or less. The formation is red clay, traversed by water-bearing gravel.

All along the margin off Dry Lake, near Yucca, it is said that flowing water can be obtained at a depth of a little more than 50 feet.

WELLS WHICH DO NOT FLOW.

In Kern County the character of the superficial strata in the center of the San Joaquin Valley is principally fine sand, quicksand, and sedimentary soil. As the hills are approached the sand becomes coarser, and gives place to gravel, and in some localities to a red, clayey loam. In some places, beds of cobblestones underlie the sandy formations, but more frequently a light-colored or yellow clay is found; this clay is the most compact toward the center of the valley, and near the hills it frequently contains fragments of shells.

Of late years important hydrographical changes have been effected by irrigation in the valley lands of the county. The surplus water from Kern River, which formerly created Kern Lake, is utilized for irrigation; Kern Lake itself is dried up, and the Buena Vista Lake is turned into a reservoir to hold water for irrigating purposes.

Since the era of irrigation, a great change has been noticed in the water plane of many parts of the valley. Thus, before the construction of the Calloway Canal, the water plane throughout districts which now subtend the canal was in many places more than 30 feet below the surface of the ground; it is now less than half that depth. In the Rosedale district, before the Calloway, Beardsley, and McCord canals were built, the water plane was from 75 to 115 feet below the surface; it is now only 15 feet to surface water.

The city of Bakersfield is supplied by the Bakersfield Water Company. This company was organized in 1883, and they obtain their supply from four wells, which are about 75 feet in depth. The formation penetrated by the wells is—

Surface soil	9 feet.
Alternate strata of sand and clay	60 feet.
Cobblestones	6 feet.

The water, even during the dry season, stands within 7 or 8 feet of the surface; it rises still higher in the spring time. Continued pumping from two Blake pumps, throwing respectively 15,000 and 34,000 gallons an hour, lowers the water about 6 feet. The works supply about 400,000 gallons a day during the summer, and probably about 150,000 gallons during the winter.

In and around Bakersfield, a good supply of water is obtained at a depth varing from 30 to 60 feet. The soil is sandy loam, from a depth of a few inches to that of 12 feet. The subsoil is usually fine sand, becoming coarser toward the bottom, and is from 16 to 50 feet thick. Beneath the sand, gravel is generally met with, or clean, washed cobble-stones, yielding an abundant supply of good water, which rises to within 5 or 10 feet of the surface.

Toward Kern Lake several wells have shown:

Black sediment soil	10 to 35 feet.
The average thickness of this surface soil is about 16 feet, and in it "alkali" water is usually struck at a depth of from 8 to 12 feet.	
Coarse sand	10 feet.
Yellow clay	18 feet.
Coarse sand and gravel	50 to 60 feet.

The strata are sometimes thicker than the above, but good water is obtained at a depth of from 100 to 150 feet.

A well was bored at Belleview, about 7 miles southwest of Bakersfield, to a depth of 960 feet. The formation penetrated is composed of alternate strata of sand and clay. Good water was obtained, which stood about 12 feet below the surface of the ground.

The following formation is reported as having been observed in several wells on the Pescadero ranch, about 16 miles west of Bakersfield:

Black soil	5 to 10 feet.
Sand	10 to 50 feet.
Hardpan	4 to 20 feet.
Gravel	4 to 40 feet.
Blue and yellow clay	4 to 30 feet.
Gravel, with good water	4 to 40 feet.

A well was bored to a depth of 920 feet at the Poso Headquarters, about 20 miles a little west of north from Bakersfield. Strata of sand and clay were penetrated to a depth of 600 feet, when sandstone was encountered, beneath which the formation was sand and gravel, with an abundant supply of water. The water in the casing stood at a depth of 60 feet. Outside the casing there was plenty of water at a depth of 25 feet, which forced its way into the casing and disappeared in the strata below. It was the opinion of the well-borer that the stratum absorbing the water was at a depth of 800 feet. From this well many sea shells are said to have been brought up.

On Kern Island, near Kern Lake, shells and fish bones are said to have been brought up from a depth of 500 feet. A few miles westward from Kern and Buena Vista Lakes the drift from the mountain has been frequently penetrated for 100 feet before any water was obtained; even then it is always very hard.

At a distance of about 3 miles west of Kern and Buena Vista Lakes it frequently contains "too much alkali even for stock." All along the western foothills the well water is hard, and the chances of obtaining it are uncertain. Potable water is obtained in some places from wells dug

SAN EMIDIO CAÑON, KERN COUNTY.

Photo. by W. L. Watts, Field Assistant.

in spots which subtend the beds of creeks, but the water is always very hard.

Oil is said to have been observed on the surface of the water in some wells a few miles from the foothills to the west of Bakersfield.

Eastward from Bakersfield, beyond the Southern Pacific Railroad track, the foothills of the Sierras are entered. The soil is gravelly, bowlders are of frequent occurrence, and the depth at which water can be obtained is uncertain.

About 5 miles southwest of Delano, on Sec. 32, T. 25 S., R. 25 E., M. D. M., a well was bored to the depth of 822 feet. Surface water was struck at a depth of 22 feet; at a depth of 265 feet the water rose to within 6 feet of the surface, and at a depth of 293 feet it rose 3 feet higher. No further raise was noticed.

In 1891 a few wells were bored a little east of Desert Well Station. At a depth of something less than 40 feet an abundance of water was obtained, but it was impregnated with "borax." The formation is said to be decomposed lava.

GOLD AND SILVER.

At Havilah mining has been prosecuted during 1891–92 on a comparatively small scale, and operations have been principally confined to working above the water level. Since this district was last reported on by the California State Mining Bureau, a Huntington mill of 6 or 8 tons daily capacity has been erected by W. J. Graham. It has been estimated that the returns from the Havilah mines during 1891 were about $10,000.

METALLIC ANTIMONY.

Four miles south of Hot Springs, on Erskine Creek, a ledge of "quartzite and porphyritic rock" was discovered, which yielded a metallic antimony (native antimony). Two tons of this metal were taken from a shaft 30 feet in depth, and 1½ tons from a cut only 8 feet deep. The deposits from which the antimony was obtained are on the same ledge, and about 1,000 feet apart. The native antimony was found in nodular masses; these nodules, which were coated with oxide of antimony and clay, varied in weight from 1 ounce to 300 pounds.

In the immediate neighborhood of the ledge, particularly for a distance of about 4 miles in a southerly direction therefrom, are many veins carrying sulphide of antimony (stibnite). In this district several antimony mines have been located and are awaiting capital to develop them.

Near the head of Erskine Creek, and about 2 miles from the above mentioned deposits of metallic antimony, is the Iconoclast Mine. This mine has been prospected by two tunnels and an open cut. The lower tunnel is 180 feet in length, and follows vein matter, which yields on an average about 24 ounces of silver and $4 of gold to the ton. There are several rich spots in the vein, from which the ore assays from $100 to $150 a ton.

CALIENTE CREEK.

About 18 miles east of Caliente Station, on Caliente Creek, some very rich silver ore has been discovered. A large specimen of silver ore, which shows more than $600 a ton by assay, was obtained in this

vicinity by Andrew Sauser, Esq., who donated it to the Museum of the State Mining Bureau.

In the same locality there are a number of narrow veins of auriferous quartz, from which the ore is profitably worked in arrastras.

At Kernville mining has been principally confined to prospecting the old workings and taking out any high-grade ore that could be found, a mill run being made whenever sufficient ore had accumulated.

Mr. J. W. Sumner, of the Tom Lane Mine, reports that for the last three years the returns from his mine have been as follows:

In 1889, 420 tons were taken out, which yielded	$9,600
In 1890, 275 tons were taken out, which yielded	6,400
In 1891, 90 tons were taken out, which yielded	2,200

All this ore was taken from the old workings, where mining had been carried on for the last thirty years. Mr. Sumner states that the mine has been worked to the depth of about 100 feet, and that for successful operation it has been found necessary to open it at a lower level, which is being done.

About 12 or 15 miles southwest of Kernville a number of veins are worked during the summer. It is said that they are narrow and pockety, but that the ore is very rich, frequently running from $60 to $150 a ton. The ore is worked in an arrastra.

Some mining has been carried on during the last two years at Rand Hill, but the writer could not obtain particulars with regard to it.

The Long Tom Mine, which is situated about 22 miles northeast of Bakersfield, is owned by Messrs. Herman & Hershfield. During 1891, this mine was worked by Frank Littlefield and J. Fisher, who straightened up the old workings for about 200 feet, and took out about 50 tons of ore. When the ore was milled it yielded $45 a ton in gold and $8 a ton in sulphurets.

At Agua Caliente, Messrs. McRay & Stuter report that since 1889 they have taken out about $15,000 worth of ore from the Jann Dosie Mine. In this mine they have run a tunnel about 80 feet, and have also sunk a shaft about 80 feet from the tunnel. They report a large lode of ore, which will mill from $10 to $15 per ton, and a pay streak running from $50 to $75 a ton. They worked their high-grade ore in a steam arrastra, which has a capacity of one ton every twenty-four hours. They say that their ledge crops out in several places for a distance of about 1,200 feet. They also own a prospect adjacent to their claim, which showed a pay streak of from 1 to 2 feet in width, which milled at the rate of $100 to the ton. This is called the Bella Ruffin, and it is said that one man took out about 33 tons of it in twenty days. Messrs. McRay & Stuter state, however, that the vein "broke square off," and that they have not been able to find it again.

In the autumn of 1891, the Fairmount Mine, on the Agua Caliente Creek, was purchased by an English company, who have erected a five-stamp Huntington mill. The lode in this mine is said to be about 10 feet in width. Discoveries of rich ore are also reported from the mouth of Sand Cañon.

The writer is informed that during 1891 the Shipsey Mine, on Basin Creek, yielded about $3,000. In this mine there is said to be much ore that is too low grade to be worked in an arrastra.

In 1891 a vein of quartz rich in gold is said to have been discovered in the old workings of the Warrington Mine.

LAKE COUNTY.

By W. L. Watts, Assistant in the Field

THE ABBOTT QUICKSILVER MINES.

These mines are situated in Lake County, about half a mile from its eastern boundary, upon the western slope of a ridge dividing Grizzly Cañon from Sulphur Creek, the said ridge forming the dividing line between Colusa and Lake Counties. The outcropping rocks upon the summit of the ridge are principally sandstone and serpentine, while the western slope is chiefly composed of shales traversed by vein matter, with which the cinnabar is associated.

These works and mines, which have remained idle for more than seventeen years, were at one time extensively operated, and much quicksilver was obtained from them. The present company commenced work in 1890. They reopened a portion of the old workings, and, having repaired the furnaces and condensers, at the time of the writer's visit, viz.: May, 1892, were reducing ore by the plant which had lain so long idle. The furnaces consist of one Knox & Osborne furnace, of 6 tons capacity, for coarse ore, and a Hughes furnace, of similar capacity, for the fine ore. The dimensions of the Knox & Osborne furnace are approximately 14 by 20 by 31. The doors of this furnace, one of which is situated at either end, are about 15 feet below the charging floor, and the discharge for the roasted ore being about 15 feet below the firing doors. This furnace consumes only half a cord of wood in twenty-four hours, the heat being maintained to a great extent by the roasting ore. The vapors from this furnace pass into an iron-lined, brick condensing chamber, wherein a large amount of soot accumulates, and thence into six iron and two wooden condensers, cooled by water. Most of the quicksilver is caught in the first three condensers.

In the Hughes furnace the fine ore descends an incline of about 45°. The flame from a fireplace at each end of the furnace passes over the surface of the ore. The roasted ore is discharged from a chute in the side of the furnace between the fire doors. This furnace consumes about one and three quarters cords of wood per day, and is not considered satisfactory. The vapor passes into an iron-lined dust chamber, where the soot principally collects, and thence into four iron and two wooden condensers, cooled by water. Most of the quicksilver is collected in the first four condensers.

A Root suction blower, running slowly, draws the vapors of both furnaces from the condensers into a 50-foot wooden flue, the escape pipe of which extends about 60 yards down hill at an angle of about 60°. The soot, some 60 per cent of which is finely divided quicksilver, is worked with caustic lime, which causes the tiny globules to collect. The residue is returned to the furnace.

The character of the ore is cinnabar, with a small amount of sulphe

selenide of mercury. The writer also obtained a very curious ore from this mine. Its physical appearance was that of a grayish mass exhibiting externally botryoidal forms, which, when broken, showed a radiated crystalline structure. An examination in the laboratory proved it to be a pseudomorph after marcasite, the trimetric crystals of pyrites being partially replaced by the sulphide and selenide of mercury, associated with petroleum.

The output of the mine since the present company commenced operations in December, 1891, to January, 1892, has been 337 flasks.

The present workings, which consist of a reopening and extension of a portion of the old workings, are situated at a height of about 2,000 feet above sea-level. A tunnel has been run into the mountain through a shale formation for a distance of about 380 feet; from the end of this tunnel drifts extend to workings in a northeasterly and a westerly direction. The westerly drift encountered vein matter at a distance of about 620 feet from the mouth of the tunnel. The first body was about 20 feet in thickness, having a course of north of west and south of east magnetic. The vein matter was principally silicious, with numerous fragments of serpentine, cemented together with light-colored, steatitic clay. Much of the adjacent shale, like that in many parts of the old workings, showed a silky efflorescence of epsomite. Farther to the east other bodies of vein matter were encountered, and between them broken and somewhat altered shale was interspersed with ledge matter. The strike of the vein matter coincided roughly with the strike of the shale, it being approximately northwest by southeast magnetic, and the dip variable, but where most observed, southerly at an angle of about 70° to 80°.

Nearly all of the ore has been found in the vein matter within a few feet of the shale, and sometimes in the shale itself. It has also been found in extensive pockets in the vein matter, which have spread out into the shale. In the ore-bearing portions of the ledge the ore is more frequently distributed as nodules and masses throughout the cementing material; it is also found penetrating the silicious and altered fragments of rock. The writer also observed a large amount of blackish opal, both in the vein matter in the mine and lying upon the dump. In the northeasterly drift vein matter was encountered at a distance of about 580 feet from the mouth of the tunnel, and the workings disclosed a similar formation to that of the other drift.

The workings at the end of both drifts are quite extensive, several large pockets of ore having been taken out.

Petroleum was associated with the ore in several places, especially in the northeasterly workings, where it flowed out upon a small stream of sulphuretted water which escaped from the vein matter. Several marine fossils are said to have been found in the vein matter.

The Distanell is a southeastern extension of the Abbott Mine, but no work was being done upon it when the locality was visited by the writer in May, 1892.

LASSEN COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

Only in two places in the county has any mining been carried on resulting in bullion shipments, and an increase in the mining area can only occur through accidental developments, the larger part of the country being covered by eruptive overflows, which obscure all indications of the presence of valuable mineral.

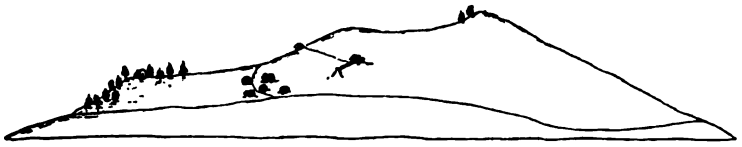
Mineral-bearing quartz veins are known to exist to the west and south of Eagle Lake, but they have never been exploited. Evidences of placer mining of a very early date are to be seen to the east of Dixie Valley, in the northern part of the county, consisting of an old open cut, the remains of a small ditch, and a wall of piled bowlders, but no gold can be found. Settlers in Big Valley, in sinking wells occasionally cut through gravel that yields some fine gold.

Of useful minerals, other than the metals, some very large deposits of a good quality of kaolin may be mentioned, which will be valuable as soon as this county is brought into more direct communication with the outside world, by means of railroads.

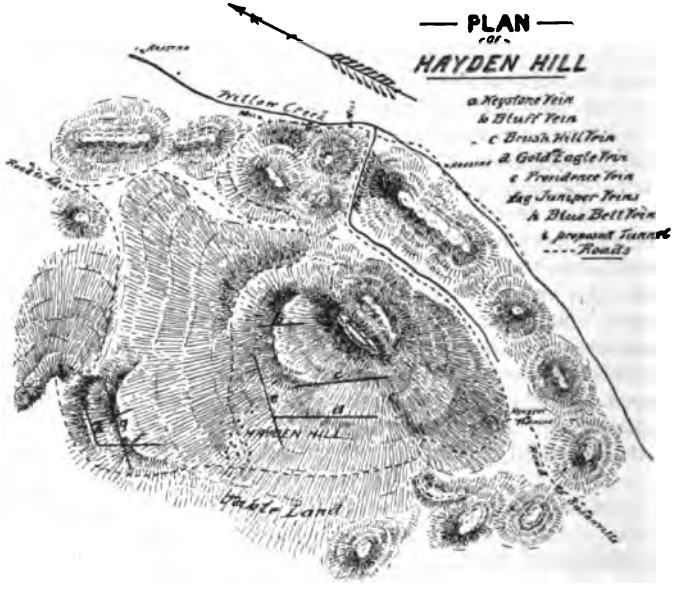
HAYDEN HILL MINING DISTRICT.

The mines of this district have been fully mentioned in previous reports. The camp is gradually decaying from lack of capital. The mines, during the twenty odd years of their existence, have yielded nearly $2,000,000 in gold bullion, and have now arrived at that stage where an expenditure of capital in the shape of hoisting appliances, and means of bringing the mines and mills into a more direct and continuous communication, are necessities. The mines have not a sufficiency of permanent water to allow of the erection of steam hoisting gear. The mills are located from 2 to 3 miles from the mines, on the banks of Willow Creek, which supplies ample and permanent water power. Climatic conditions make it impossible to haul over the roads during several months in the winter and the early spring. These conditions combined have compelled the owners to adopt a very expensive and ruinous method in their mining operations. Now, at a depth of 300 feet, the mines are nearly at a standstill. Efforts were made during the past year to get the different mining companies to unite and drive a deep tunnel to cut the veins at a depth of about 700 feet, the tunnel to start a short distance from the creek, at the point "T" in the accompanying map of Hayden Hill. Lack of unity among the parties frustrated the scheme.

The district is well worthy the attention of parties with means at their disposal, for the furtherance of bone fida mining undertakings. The topography of the country is such as to favor the driving of a deep tunnel to crosscut the veins showing on the surface. Such a tunnel would



HAYDEN HILL FACING SOUTH WEST.



also solve the question of ore hauling, as the distance from the mouth of it to a suitable mill site on Willow Creek, at the outlet of White Horse Cañon, would be from a quarter to one half a mile, on a very regular grade. This arrangement would permit of the profitable working of the large bodies of low-grade ores that have to be left as unprofitable under the existing circumstances.

During the past season only three or four of the mines were taking out and working ores, the bullion yield being stated at about $12,000. About twenty men found employment. One mine, which has been idle during the past year on account of the accidental death of the owners, has resumed operations with a small crew.

The mines around Susanville, in the granite on the Diamond Mountain range, are doing little. A few men are striving to develop some veins which have been found to contain gold enough to pay for its extraction, but no great depth has been obtained and the operations are simply prospects.

LOS ANGELES COUNTY.

By W. H. Storms, Assistant in the Field.

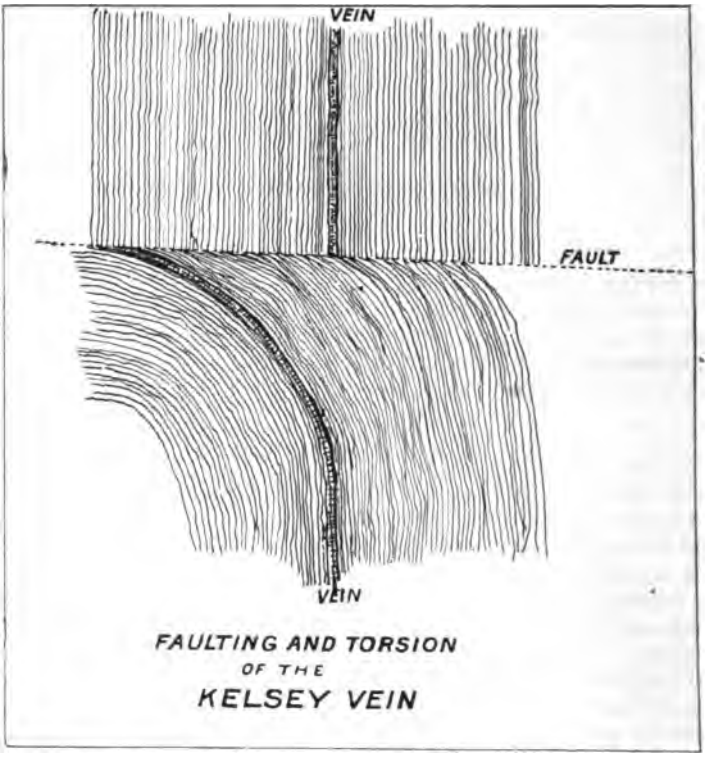
The mining industry in this county is not as extensive as that of some of the neighboring counties, but there are mines in Los Angeles County of unquestioned value, and others which have a prospective value, dependent to a great extent upon the success achieved in working certain base ores, which occur in comparative abundance.

THE KELSEY MINE.

One of the most interesting mines in the county is located in the rugged mountains about 8 miles from the town of Azusa, in the San Gabriel Cañon. It is commonly known as the Kelsey Mine, and has become famous as a producer of silver ore of fabulous richness.

The country is made up almost entirely of metamorphic rocks, having schistose, gneissoid, and massive structure. Both hornblende and mica occur in these rocks abundantly, the former being frequently altered to chlorite, or by further change to epidote. Dikes of porphyritic rock have been intruded into the crystalline schists. In the immediate vicinity of the Kelsey vein are intrusions of a dark green, much decomposed, and shattered rock, probably diorite. Faults, great and small, are numerous throughout the region. Within a few hundred feet of the mine is a great fault, which may be plainly seen cutting the mountain. The displacement must reach many hundreds of feet. It has resulted in bringing in contact on a horizontal plane rocks of entirely different character. On the south side of the fault the rocks are made up of quite regularly bedded micaceous sandstones, more or less schistose, and having a prevailing buff or light gray color. These rocks dip east at an angle of 20° to 30°. On the north side of the fault the rocks are harder, of a dark gray color, and containing considerable hornblende. These rocks are more gneissoid and massive than schistose. The dip is much less regular than on the south side of the displacement. Large, lenticular masses of quartzose and feldspathic rock are of frequent occurrence in the hornblende gniess, evidently the result of the segregation of the contained minerals. On the whole there is much more evidence of the disturbance on the north side of the fault than on the south side. It is in this area of greatly disturbed strata that the Kelsey vein has formed.

The vein is of the fissure type and occupies the line of a fault plane, that at first, perhaps, was a mere crack, but which has become enlarged by the movement upon themselves of the rock masses forming the walls, resulting in a grinding and crushing of the rocks by the attrition and pressure incident to this movement. Into this crevice mineral waters found their way, carrying in solution the minerals now constituting the vein.



FAULTING AND TORSION
OF THE
KELSEY VEIN

The Ore.—The silver occurs as native and as glance (argentite), possibly partly as chloride and in combinations with sulphur, cobalt, and arsenic. The associated minerals are cobalt bloom (erythrite), a hydrous cobalt arsenate, nickel arsenate (annabergite), carbonate and silicate of copper (chrysocolla), iron oxide, and black oxide of manganese in a gangue of baryta (heavy spar), with calcite (lime spar) and some quartz. A clay selvage usually separates the vein material from the wall, this feature being well developed in places on the foot wall side, as though open crevices had occurred and the finely divided material which was carried by the percolating waters had found a resting place when an open space was reached, the absence of any current permitting the material to settle.

The clay may have been derived in part from the decomposition of the overhanging wall, the fine silt settling by gravity on the foot wall side of the vein. In places a soft, clayey gouge constitutes the entire vein filling, suggesting that the clay selvage and gouge are also partly due to the attrition of the walls. Galena occurs sparingly in small disseminated crystals, but the occurrence is so infrequent as to be scarcely worth mentioning. In width the crevice varies from a thin seam to over 4 feet. A banded structure is not uncommon in the vein.

The rocks inclosing the vein differ in various parts of the mine. A much decomposed rock, containing iron in the form of carbonate, occurs frequently, while a chloritic, more or less schistose, sometimes massive,

rock, also plays an important part in this connection. The dike of dark basic rock, resembling diorite, previously referred to, is exposed at numerous places throughout the workings, often in contact with the vein, or close to it. Since its formation the Kelsey vein has been subjected to severe torsion, which has resulted in abrupt fracture and displacement. To me it seemed very probable that the vein was the result of chemical precipitation, and no doubt, to some extent, the replacement of country rock along the line of a fissure or fault plane; that subsequent to the filling in of the vein the region was subjected to further violent disturbances, which fractured the rocks along an east and west course, and causing the turning of a large mass of rock formation lying south of this fault to the west. The vein being included in the general movement, was deflected from its natural course north and south. I came to these conclusions from close observations taken along the surface of the ground on the course of the vein, and in all accessible underground workings.

Most of the ore extracted from these workings has been high grade, usually running over $200 per ton, small lots often assaying several thousand ounces. The property, at the time of my visit last spring, was under the management of Dr. Endlich, E.M. This gentleman was making every effort to systematically open and recover a vein that had been as systematically and outrageously gouged. The workings were in bad condition and at some points were positively dangerous. The mine was gradually assuming an improved appearance and promised to yield better returns than ever before. A good mill has been erected at the foot of the mountain, in the San Gabriel Cañon, where a large stream of water flows during the entire year. An office, boarding house, stables, corrals, etc., had been built for the accommodation of men and animals. In adddition to this I found a complete assay office and chemical laboratory, and here Dr. Endlich was experimenting with the rich cobalt and nickel ores. As a result of his labors in this direction he exhibited several bars of cobalt speiss containing a very high value in silver. The assorted ore contains from 7 to 15 per cent in cobalt, 2 to 3 per cent nickel, and from 1,000 to 1,400 ounces silver per ton.

Dr. Endlich thus describes his methods: "The ore is crushed through a twenty-mesh sieve, mixed with sufficient litharge to produce an 8 per cent charge, and enough borax is added to take up the gangue (quartz, heavy spar, carbonate of lime, magnesia, and iron). Carbonate of soda and flour are mixed with the charge. If the percentage of arsenic in the ore is sufficiently high to produce speiss none is added; otherwise some metallic arsenic is mixed in. Some sulphides in the ore and reduced sulphur from the heavy spar are utilized to produce mattes. The mixture is melted in large Dixon crucibles; the slag poured off, and the metallic product allowed to cool. The bars obtained are composed of lead, silver, cobalt, nickel, arsenic, and sulphur, principally; the lead being in the form of sulphide, the cobalt and nickel in the form of arsenides. The bars contained from 4,500 to 7,000 ounces silver per ton. The slag contained a trace of silver, and averaged about 0.75 per cent cobalt, which can be worked over by arsenizing, if desired, and the cobalt obtained in the resulting speiss."

At this writing about 560 pounds of ore has been treated in this way and the product shipped to Balbach's works in Newark, N. J., for refining.

THE VICTORIA MINES.

This property is situated but a short distance from the Kelsey Mine. The Victoria Mine was operated under English management for an English syndicate two or three years ago. Lately all operations have been suspended. The property, whatever it may be worth, is a monument to mismanagement of the worst sort.

THE LORDSBURG STAMPEDE.

In the month of March, 1892, the report went abroad that rich silver and gold-bearing rock had been found in the mountains north of Lordsburg, 28 miles east of the city of Los Angeles. So glowing were these stories that a general stampede for the new mining field ensued. Farmers left their homes, merchants and clerks in some instances temporarily closed their stores to join in the rush to Lordsburg. Unfortunately the stories proved to be unfounded, and, after three weeks of excitement, all had left the mines excepting a very few, who still had hopes of making a find.

CEDAR MINING DISTRICT.

Fifty-five miles by rail northeast from Los Angeles, on the line of the S. P. R. R., is the Cedar Mining District, the principal village being about the railway station called Acton. In the low hills about Acton, which rise out of the valley that skirts the northern base of the San Gabriel range of mountains, are located the gold mines which have been worked for many years by Mexicans and Americans.

THE RED ROVER.

This is the name of the principal mine in the district. It was located and worked many years since by Mexicans, but has during the past eight or ten years been in the hands of Americans. The vein strikes northwest and southeast, dipping to the southwest at an angle of 50° from the horizon. The rock is a white, fine-grained, saccharoidal quartz, showing in places bluish bands. It contains free gold in variable amount, with some iron sulphuret. A very large amount of quartz has been stoped from the vein and crushed in various mills.

The Red Rover is quite extensively developed, the new vertical shaft being down over 400 feet. The old inclined shaft, which is sunk on the vein, is down 220 feet. Several levels are run out from both these shafts, which are 200 feet apart. The new shaft was sunk between the main vein and a spur which branches from it. A crosscut was run out toward the spur, which is opened on the surface, but it was found it did not go down. A crosscut was then run toward the main vein, which was found intact, and a drift was carried in 60 feet on the vein.

The country rock is mostly massive metamorphic, very much broken and faulted. Nearly every mine in the district has been displaced more or less by these faults. For some reason the Red Rover has been shut down for some months past. It is understood that operations are to be resumed.

THE NEW YORK MINE

Is situated within half a mile of the Red Rover, and is similar in character. The quartz is said to mill $10 to $25 per ton. The owner has a five-stamp mill, which is complete and does good work. The vein is from 1 to 3 feet in width. It has produced considerable bullion.

Other mines of the vicinity are the Topeka, Union, Escondido, King of the West, and Santa Clara, each of which has seen better days. The first three mentioned have been large producers, but are worked down to the water line, and a base ore proposition now faces the owners in the form of iron pyrites.

IN THE MAIN RANGE.

Up in the main range of the San Gabriel Mountains, on the north slopes of this rugged chain, are located a number of veins, on which considerable work has been done. The veins are well defined, ranging from 1 to 4 feet in width, striking northwest and southeast, and dipping uniformly to the northeast at a high angle. All of these veins contain gold, but all quickly run into sulphurets. All the mines are idle at present, but something brighter is hoped for. The sulphurets are said to contain sufficient gold to make chlorination profitable. If this is actually the case there is an abundance of material to work upon.

LIPARITES AND TUFAS

In the region about Acton are many hills of liparite (quartz-bearing trachyte) and tufa, which are identical with the rhyolites of the Calico region—the same violet-brown, porphyritic liparite; the same pea-green and buff-colored tufas; the same conglomerate; in fact, an exact fac simile of the Calico range. There are no great beds of sedimentary rock, however, and these liparite hills are comparatively small, isolated masses. As far as my knowledge goes ores of silver have never been found in these rocks in the Acton district. Careful prospecting may possibly discover such ores.

PROSPECTS OF THE CAMP.

Owing to the fact that the gold mines of this district have been worked to the water line, almost without exception, what now remains to be done to perpetuate the prosperity of the district, is to concentrate the sulphurets, working them by chlorination in works built in the district. Wood and water are both obtainable at moderate cost, and the sulphuretted ores of this district that contain but a very few dollars per ton should pay. The cost of mining, transportation, crushing, and concentrating should not exceed, ordinarily, $5 per ton of quartz, and the expense of treating the concentrates should be under $10 per ton. Base ores containing $10 per ton as it comes from the vein should realize a profit in this district, and I am told that many of the mines produce rock of a much better grade than that mentioned.

THE ALPINE MINES.

Not far from Acton, in the low hills overlooking the Antelope Valley. are the mines of the Alpine Plaster and Cement Company, a Los Angeles corporation. Here a deposit of gypsum is being mined, the material being sent to Los Angeles, where it is manufactured into plaster of Paris. Fifteen tons of the raw material are consumed daily.

THE PLACER DEPOSITS.

Near Newhall the placer mines are worked more or less every season. There seems to be a large area over which gold is distributed in that section, but usually the pay is too small to make mining profitable. Various kinds of gold-saving machines have been used in the district, with varying success. The placer regions hereabouts, including Dry Cañon, La Cañon de Los Murtes, Casteca Cañon, and the San Francisquito, have all produced a large amount of gold, but to the individuals working these alluvial deposits great fortunes never came. The Newhall placers are being worked systematically and cheaply, and I am told with good results. Upon the flanks of Mount San Antonio, I am told miners obtained good results during the entire spring and early summer season of the present year. Coarse gold is found up there near the head of San Antonio Cañon, at an altitude of nearly 8,000 feet above the sea.

BUILDING MATERIAL.

There are a number of very good quarries of building stone in Los Angeles County. Granite is quarried all along the San Gabriel range, from the Cañadas to the San Antonio Cañon. The rock obtained is a beautiful stone of uniform grain and capable of withstanding a tremendous pressure. Sandstone is obtained in any desired quantity near San Dimas, on the line of the Southern California Railroad. In the San Fernando Valley, also, good sandstone is quarried.

MARIN COUNTY.

By W. L. WATTS, Assistant in the Field.

The mineral resources of Marin County that have been hitherto developed, may be reckoned among those of practical utility rather than of metallic value. The existence of the valuable and precious metals in Marin County, as mentioned in previous reports, was, however, sufficient to cause some excitement in the early days of California.

At a point visited by the writer, croppings of copper ore were found, from which a fair grade might be obtained by sorting, although the average of the ledge was of little value.

The oil and gas of Bolinas have also received some attention in years gone by, but the inefficiency of the boring tools in use in California at that time can hardly be said to have fairly tested the oil and gas bearing formations.

Notable among the attractions of the picturesque shore of Marin County are the hot springs of Rocky Point. At present their existence is by no means widely known, but lying as they do, almost within sight of the lights of San Francisco, they may be reckoned among the mineral resources of the county, by reason of the dollars they are likely to draw from the pockets of visitors.

WATER.

The principal water supply of San Rafael, San Quentin, and Ross Valley districts is from the mains of the Marin County Water Company. This company obtains water from Lake Lagunita, an artificial reservoir about 7 miles from San Rafael, and situated at a height of about 700 feet above that town. This reservoir comprises an area of 22 acres; it is 42 feet deep at high-water mark, from which point there is a constant overflow during the rainy season.

Lake Lagunita was formed by damming a valley on the northern slope of Mount Tamalpais. This enterprise was commenced by W. T. Coleman in or about the year 1872, and he sold the waterworks and privileges to the present company in 1877. The cost of water supplied by the Marin County Waterworks, at meter rates, is as follows: 10,000 gallons per month or under, 45 cents per thousand; 10,000 to 20,000 gallons per month, 35 cents per thousand; over 20,000 gallons per month, 30 cents per thousand. This company also obtains water from Sweet George Spring, about 3 miles south of the reservoir; the water from this spring flows into the flume supplying the town of San Rafael. The Ross Valley supply is taken principally from Bill Williams Gulch; this water right is also owned by the Marin County Water Company. The water from Worn Springs also flows into the Bill Williams main. A reservoir of about 300,000 gallons capacity has been formed by throwing a dam 12 feet in height and 40 feet in length across Bill Williams

Gulch, and from this reservoir the water is piped. A flume from Lagunita Lake carries the water which supplies San Rafael a distance of about half a mile to a hopper, whence it is piped about 6½ miles to the town. The Marin County Water Company has other water rights, which at present are not used; the principal one of these is the water right of Cataract Gulch, on the Bolinas road, distant about 4 miles south of Lagunita Lake. It is the intention of the company to construct a new dam a short distance from Lake Lagunita, in order to create a larger reservoir at a slightly lower elevation. It is estimated that the new reservoir will contain 195,000,000 gallons. The barometric height of the high-water mark at the new reservoir has been estimated at 690 feet above the office of the company at San Rafael. The barometric height at the junction of the north and south forks of Sweetwater Gulch is 650 feet. That of Cataract Gulch, at a point about 300 yards up the gulch from the county road, is 600 feet. It has been estimated that the approximate discharge from the main flume of Lagunita Lake is 400,000 gallons in twenty-four hours in winter, and about 1,000,000 gallons in twenty-four hours in summer.

Throughout the hills of Marin County, private supplies of water are obtained from springs, or by tunneling through several strata of rock, which usually stand at a very great angle, the water being found either at the point of contact between the strata or seeping through the more porous formation. A tunnel of from 80 to 130 feet in length is said to be sufficient as a general rule to furnish water for one family, and sometimes for more; still, tunneling for water in a rocky formation is an uncertain expedient. Thus, when the writer visited Larkspur, only a small supply of water was being obtained from a tunnel 140 feet long, which had been run under such conditions, but the supply from the tunnel had to be helped out by pumping from a well in the bed of the adjacent creek. A second tunnel was at that time being made. The formation penetrated was a metamorphic sandstone and shale, passing into a rock which, from a casual examination, resembles serpentine.

Farther down from the above mentioned tunnels, a well was dug, and after passing through 8 feet of adobe and 16 feet of shale, a spring was struck, which flowed at the rate of about 5 gallons per hour. A fair quality of water was obtained at a depth of 24 feet in a metamorphic sandstone near the creek.

Several attempts have been made at the Hotel San Rafael to obtain water by sinking a shaft and crosscutting the formation, and one boring that has been made there is said to be 900 feet in depth. It is reported, however, that the yield of water is small. Another shaft was commenced in September, 1891, the result of which was not known at the time of this writing. Several other attempts to obtain water by digging and boring into the rock formation near San Rafael have been far from satisfactory. The formation penetrated at the Hotel San Rafael in 1890 was yellow clay, 55 feet, and shale rock, with streaks of lime, 500 feet.

MINERAL AND THERMAL SPRINGS.

Besides numerous mineral springs associated with the gas-yielding rocks, and mentioned in connection therewith, a group of hot mineral springs is situated near Rocky Point, some 8 miles southeast from Bolinas.

On the eastern side of Bolinas Bay the unaltered formation gives place to metamorphic rocks. About 6 miles south of Bolinas is Willow Camp, on the East-koot Beach; it is quite a favorite bathing resort. A grove of willows at that point has been patronized by campers for many years, and is now becoming more widely known.

About 1½ miles from Willow Camp and some 6 miles northwest from Point Bonita are several hot sulphur springs. Between the willows and the springs the shore is guarded by precipitous cliffs of highly metamorphosed, sedimentary strata, conspicuous among which are highly contorted, jaspery slates; and at one point a very high degree of silicification has been attained, and croppings of quartz present themselves.

About half way between Willow Camp and the hot springs an alum shale is met with, the surface of which is covered with efflorescent salts; and associated with the shale is much iron pyrites. The rock whence the hot springs issue is highly metamorphic, and iron pyrites are abundantly scattered through it. The water of some of the springs is as hot as can be borne by the hand; the adjacent sand is quite warm, and the air is redolent with sulphuretted hydrogen. These springs are all situated below high-tide mark to the west of Rocky Point, in the vicinity where the waters of Steep Ravine reach the ocean. The shore land belongs to the Throgmorton ranch, but Mr. Houston Jones informed the writer that he has made application to the Government for a title to the springs.

EL TORO SPRING.

This spring is situated on the property of J. W. Taylor, near Novato, and the medicinal character of its waters has been known for many years. The following analysis of the water was made by William T. Wenzell, of San Francisco:

	Grains in 1 Gallon.
Carbonate of soda	7.127
Carbonate of lime	.641
Carbonate of magnesia	.709
Chloride of sodium	2.099
Chloride of potassium	1.271
Sulphate of magnesia	.617
Oxide of iron	.116
Alumina	.040

Carbonic acid, 37 cubic inches.

COAL.

Small seams of coal are found in several places in the county, notably on the ranch of C. Murray, about 3 miles north of Nicasio.

Some prospecting for coal has been done about 2 miles north of Bolinas, on the McGovern ranch. No coal, however, is in sight, the formation exposed being a dark-colored shale.

BUILDING STONE.

Besides the Hotaling quarry, in the southwestern edge of San Rafael, which was described in the Tenth Annual Report, some rough stone for gutter work and macadam has been taken out on the Coleman tract.

A small amount of sandstone has also been quarried near Mount Tamalpais cemetery. At other places the formation is greatly disturbed; it stands at a great angle and is traversed by numerous calcareous vein-

lets. It is unlikely that building stone would be extracted with profit from either place on a large scale, on account of the large amount of rubble rock which would inevitably accumulate. The physical appearance of the rock, however, indicates a fair tensile strength, and the rapid increase of villa residences in San Rafael and vicinity will, no doubt, create a local demand for building stone; indeed, the stone used in the construction of the theological seminary at Ross Station is taken from the Hotaling quarry referred to.

BASALT BLOCKS.

The DeLong quarry, which is situated on the DeLong ranch, about 5 miles from Novato, is still leased by P. Gallagher, who reports a falling off in the price of blocks, and a decrease in the number of men employed in his quarry.

Mr. Taylor, who owns a quarry about 2 miles north of Novato, states that his basalt quarry is about three quarters of a mile from the shipping point at Taylor Slough, and that he is prepared to supply not only blocks, but dimension stone, and to deliver the latter at San Francisco at 80 cents per cubic foot. He attributes the depression in the block business to the extensive adoption of bituminous pavement in San Francisco.

It appears, from conversation with Messrs. Gallagher and Taylor, that they can deliver specification blocks in San Francisco at a price of from $45 to $50 per thousand, and street railroad blocks at from $25 to $27 per thousand. The specification blocks cost Mr. Taylor 2½ to 3 cents each in the quarry, and the railroad blocks from $12 to $15 per thousand. The same gentlemen state that bargains in job lots can frequently be picked up at lower figures. Basalt suitable for block making is also found on the Burdell ranch.

SILVER AND GOLD.

Besides the old prospect workings, which have already been mentioned in these reports, quartz assaying a few dollars in gold and silver is frequently met with in the metamorphic rocks of Marin County. The discovery of it generally results in a little work being done and the eventual abandonment of the claim. This was the case in regard to a claim situated on a spur of Mount Tamalpais, which runs down to the ocean between Point Bonita and Rocky Point.

A cropping of quartz was also discovered on the property of S. S. Randal, about half way between Bolinas and Olema. Work was commenced upon it in 1889, and a prospect hole was sunk to a depth of about 10 feet; a small, irregular vein of quartz was exposed, having an approximate strike of west of south by east of north magnetic; the foot wall was sandstone, and the hanging wall a decomposed and somewhat altered shale. An assay of the croppings showed $1 25 in gold and $7 85 in silver. Subsequent assays showed less value, and the claim was abandoned.

Some prospect workings on the Morse ranch, on the east side of Bolinas Bay, are said to have produced quartz assaying a few dollars in gold and silver.

COPPER.

At an early day, some work was done on a copper claim in Union Gulch, near Woodville, then called Dogtown, about 3 miles north of Bolinas, on the Olema road. Several tons of ore are said to have been taken out and shipped to England, but the cost of transportation was too heavy, and the work was abandoned. There is a somewhat similar history connected with old workings in Pike Gulch, a mile or so to the south of Union Gulch. The old workings in Union Gulch consist of a shaft and a tunnel, which was run several hundred feet into the mountain in an easterly direction. A portion of the tunnel still remains, it being well timbered. The rock penetrated is metamorphic sandstone, but the shaft is filled up.

A short distance up the gulch from the tunnel above mentioned, on land owned by W. W. Williams, there is a cropping of vein matter about 4 feet in thickness. The average of the croppings was evidently very low grade, but ore could probably be sorted that would yield several per cent of copper. The ledge runs approximately northeast by southwest and its pitch is southeasterly at an angle of about 70°. The gangue rock appears to be the same in character as that of the walls, namely, altered sandstone, but there is much quartz associated with it. The croppings show iron pyrites and iron-stained quartz. No work had been done on these croppings when they were visited by the writer; they are about 3 miles distant from Bolinas Landing. The old tunnel was, no doubt, run to cut this vein farther to the southwest.

IRON AND MANGANESE.

Iron and manganese occur in considerable quantities on the ranch of A. Maillard, in San Geronimo Township. Large masses of the ore are scattered over the hillside, although no regular ledge has been discovered. A sample of this ore was sent to the Bethlehem Steel Works, in Pennsylvania, and pronounced excellent for the manufacture of "Speigleisen." The Bethlehem Steel Company offered $30 a ton for the ore, delivered at their works.

The sample sent showed by assay 46 per cent oxide of manganese (MnO_2), the rest oxide of iron (Fe_2O_3). The locality where the ore was discovered is about 8 miles from San Rafael.

PLUMBAGO AND CHROMIC IRON.

Plumbago is reported to have been discovered on the Maillard ranch, in San Geronimo Township; and irregular masses of chromic iron, which have shown by assay 52.1 per cent chromic oxide, have been found in the same vicinity.

BRICK CLAY.

There is also a good quality of brick clay on the Maillard ranch. Some brick have been manufactured from it for local use, and samples of pipe, tile, and pressed brick were shown the writer, which had been made from clay obtained there.

The time at the disposal of the writer was insufficient to allow the

necessary permits to be obtained for inspecting the patent-brick yards between San Rafael and Novato.

In 1891 a brickyard was established by the Remillard Brick Company at Green Brae. The plant consists of one continuous Hoffman kiln, of a capacity of 12,000,000 bricks a year. About one hundred men are employed at these works, but no Chinese are hired. The bricks hitherto manufactured at this yard have been common machine-made brick. Prices have ranged from $6 to $7 per thousand, f. o. b. the boat at Millbrae.

MENDOCINO COUNTY.

By W. L. Watts, Assistant in the Field.

Hitherto Mendocino County has not assumed any importance as a contributor to the mineral wealth of the State; hearsay, however, would give the recent discoveries of coal at Round Valley a respectable place amongst the limited coal measures of California.

It has been a disappointment to the Mining Bureau not to be able to inspect the Round Valley coal mines, but the department hopes, before the issue of the next report, that legal difficulties connected with these mines will be so adjusted that the necessary permission for their inspection may be obtained.

The bituminous formation at Point Arena has as yet received but little attention at the hands of investors. The facilities for water communication, and the bituminous rocks in sight at Point Arena, warrant any one who may require bituminous rock for the San Francisco market carefully to investigate the locality.

Prospecting for quicksilver and the precious metals has been carried on to a limited extent among the metamorphic rocks in the higher portions of the Coast Range in Mendocino County; and if those engaged in the work will forward samples of their discoveries to the Mining Bureau, and furnish such information that Field Assistants can readily find the localities, geological investigation will be made by this department before the next report is issued.

COAL.

The most important discovery of coal in Mendocino County is that in the Round Valley district. Unfortunately, owing to the legal difficulties in which this property was involved at the time the writer visited the county, permission to inspect the mines could not be obtained.

Coal prospects are, however, reported near Boonville, on the road from Cloverdale to the coast, and also near Kibbesilla.

GOLD AND SILVER.

Some prospecting has been done on the Garcia River, especially on its northern fork, and it is said that specimens from this district have assayed $7 to the ton in silver.

Mr. H. Symonds, of Point Arena, informed the writer that men living at the headwaters of the Garcia and Navarro Rivers frequently brought him specimens which assayed several dollars in the precious metals. Unfortunately the time at the disposal of the writer was not sufficient to allow a visit to these interesting portions of Mendocino County.

On the ranch of R. A. Smith, on the Navarro Ridge, about a mile north of the Navarro Post Office, some prospect work has been done. At one point a shaft about 10 feet in depth has been sunk near the crop-

pings of quartzose vein matter. Specimens from these croppings are said to have shown some free gold. The strike of the croppings appeared to be northwest by southeast, magnetic. The inclosing rocks were decomposed and altered shale.

Farther down the hill, a prospect tunnel, upon which work was still in progress, had been run for about 100 feet in a somewhat altered sandy shale, impregnated with silicious and calcareous infiltrations.

Prospect workings are also reported farther inland upon the Navarro Ridge, and a quartz ledge assaying $8 per ton is said to have been struck.

QUICKSILVER.

Native quicksilver is said to have been discovered about 5 miles west of Orr Springs. A mining location is said to have been made and some work done on a cinnabar discovery, on Pepperwood Creek, in Sec. 20, T. 11 N., R. 14 W., M. D. M.

RED PAINT.

A large deposit of ferruginous rock is said to occur at Red Mountain, about 6 miles south of the Humboldt County line. It has been used as paint by many settlers in that portion of Mendocino County.

MERCED COUNTY.

By W. L. Watts, Assistant in the Field.

BUILDING STONE.

A good quality of sandstone is obtained on the Ivett ranch, near Merced Falls. These falls are situated upon the western boundary of the auriferous slates, which here have a strike of west of north by east of south, magnetic, and stand at a great angle. In places a light-colored sandstone rests unconformably on the slates, occasionally forming low hills, as at the Ivett ranch.

From Merced Falls, low hills of this sandstone extend in a southeasterly direction, rising to the height of about 300 feet above the river. This sandstone can be traced from the Tuolumne River and crops out here and there as far south as the Mariposa Creek; but it has not been followed south of that stream.

On the south bank of the Merced River, on the ranch of G. P. Kelsey, in Sec. 9, T. 5 S., R. 15 E., M. D. M., a slight elevation shows the auriferous slates standing almost perpendicular, having a strike west of north by east of south, magnetic. A quartz conglomerate rests nearly horizontally on their upturned edges. The cementing material is silica and oxide of iron—the pebbles of the conglomerate sometimes coalescing and forming a quartzite. The upper portion of the elevation is composed of light-colored sandstone, similar to that already mentioned, resting conformably on the conglomerate. About a quarter of a mile farther southward a similar sandstone forms bluffs 200 or 300 feet in height, from which the writer obtained fossils that were identified by Dr. J. G. Cooper as *Cardita planicosta*, showing the formation to belong to the Cretaceous B (Chico-Tejon) series.

A few hundred yards from the outcropping slates at the base of these bluffs, the sandstone has been quarried for local purposes. A breast of about 6 feet is exposed. The formation is almost horizontal, but a close inspection leads to the conclusion that it has a slight pitch to the southwest. The stone is a fine-grained silicious rock, splitting readily in any direction. The quarry is on the land of G. P. Kelsey.

Farther to the westward the sandstone is overlaid by trachytic tufa, which in some places is interstratified with light-colored clay. This tufa, which forms high bluffs on the banks of the Merced River, can be traced skirting the foothills between the Tuolumne and Merced Rivers, and how much farther south the writer could not learn.

WATER.

A well was bored to a depth of 1,013 feet in 1890–91 on the Sandy Mush ranch, about 13 miles southwest from Merced City. Flowing water was obtained between 203 and 207 feet. Nineteen different flows were struck,

the strongest being at 665 and 680 feet. The water flows 1½ inches over a 10-inch casing.

In the Rotterdam colony, near the Yosemite Lake, a well was bored about five years ago to a depth of 60 feet, and in it the water stood at 25 feet below the surface of the ground. The writer was informed that the water had gradually risen until it is now a flowing well, the change being attributed to the increased supply from irrigated lands and the proximity of the Yosemite Lake, which is about a quarter of a mile eastward from the well.

In 1889 a well was bored on the Newman ranch, in the northwest corner of the county, to a depth of 411 feet. The water flows 4½ inches over an 8-inch casing, but it is brackish.

MONTEREY COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

Separated from San Benito County by the Gabilan range, and from the Pacific Ocean by the rugged bluffs of the Santa Lucia range, which also partially incloses the southern part of the county, adjoining San Luis Obispo County, the main drainage is to the north until it reaches Pajaro Valley, through which the inland waters, west of the Mount Diablo range, and from the south, gain an outlet to the ocean, flowing west into Monterey Bay, forming the northern boundary of the county. As the inducements of rich and extensive placer grounds are lacking in the Santa Lucia range, and the region being extremely difficult to penetrate, it has not been prospected in anything like the manner of the main range of the Sierra Nevada Mountains; consequently, we know of but one organized mining camp in the 100 miles of length of this western portion of Monterey County, and that has not attained sufficient importance to repay the county the expense of making a wagon road over the 25 miles that separate it from the valley along the Nacimiento River.

As the western slope of the Gabilan as far as it belongs to this county has no known valuable mineral-bearing deposits in the northern section, the review of the county was confined to the southern portions on both the east and west mountain ranges from King City, a small railroad town in the southern part of Salinas Valley east of the Salinas River and about one half mile away from it.

The economic minerals of this section of the Gabilan range consist of oil, coal, lime, and bitumen, and are but slightly developed. An effort is being made to bring into general use in the county and prepare for shipment to neighboring parts of the State, a bituminous rock that from practical tests made can be put down on the streets and sidewalks just as it is dug from its bed, and when rolled or rammed down forms a solid, smooth, and in every way desirable road material. It has been used on the streets in King City, and more particularly at the east approach to the Salinas bridge, where it has been subjected to considerable hard traffic. This deposit of bituminous sandstone is situated about 11 miles east of King City, and about 9 miles from the railroad, at an altitude of about 700 feet, or about 500 feet higher than the railroad track at that place. It covers an area of about 100 acres on Secs. 14 and 15, T. 19 S., R. 9 E., M. D. M., and has a general north and south trend. A small face about 9 feet in depth has been uncovered at one place.

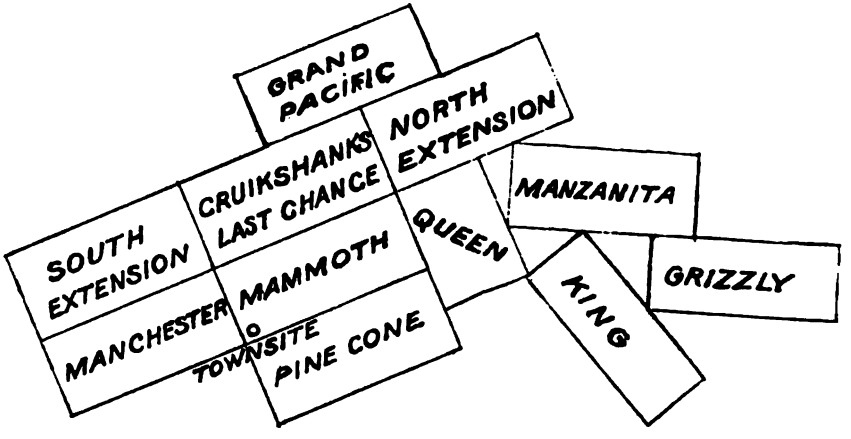
LOS BURROS GOLD MINES.

These mines are situated about 45 miles from the railroad at King City in a southwesterly direction, on the west slope of the Santa Lucia range, at an altitude of 2,800 feet, facing the ocean, from which the little camp on Alder Creek, around which the mines are situated, is distant about 3 miles in an air line.

To reach these mines the stage line to Jolon is taken, where in former years considerable placer mining was done, the entire neighborhood being largely covered with gravel. Since the title to the different grants that cover so much of this county was confirmed, about eight years ago, the owners of the lands have forbidden placer mining. The gold obtained here sold for $18 an ounce, and was mostly very fine. A large company of Chinese were the principal operators, and it is stated that in places in the immediate neighborhood of the village $5 a day to the pick has been made.

About 20 miles northwest of this place at Rockland, on the coast near to Pico Blanco, there were formerly three large, continuously working limekilns in operation on a deposit of metamorphic lime that approaches the coast. A few miles south of Jolon was another limekiln in operation, working on a large shell deposit. Both are idle at present.

To reach the gold mines pack animals have to be taken at Jolon, although a wagon road continues across the valleys of San Antonio, Stony Creek, and Nacimiento. After crossing the latter the trail immediately commences to ascend the first of the spurs, which consists of sandstones and conglomerates; beyond, in flanking another ridge, serpentine crosses the trail for quite a distance, and large blocks of float quartz are scattered over the hillside from a source above. At a point several miles beyond masses of float quartz are again observed, while below the trail the outcrop shows sandstones and shales, and in one place conglomerate rock. The main ridge is crossed by the trail at an altitude of 3,600 feet, the formation being metamorphic sandstone. From here down to the camp altered slates, serpentines, and limestone follow in succession. The veins of quartz that are being mined are mostly near the contact of a serpentine and slate belt.



RELATIVE POSITION OF BURROS MINES

The mines that are being worked are the Manchester, the Last Chance (or Cruickshanks), the Queen, the King, the Charleston (formerly called Grand Pacific), and the Grizzly. Continuous work was not being carried on in any of the mines when visited, the most active in development work being the Last Chance and the Grizzly. The latter has lately been incorporated. The quartz veins are not usually large, and carry about

2 per cent of sulphurets, generally copper sulphides; one of the claims nearest the summit, not working at present, contained a large amount of stibnite (sulphide of antimony), but it has not been found in any of the other claims. The sulphurets are not high grade, ranging from $20 to $50 per ton. The value of the ore lies in the free gold.

On account of the difficulty of bringing in freight, and the few reduction works in the camp, nothing carrying less than $12 per ton in free gold is considered worth handling. The charges for freight are 2½ cents a pound. The cañons and ravines below the mines contain scraggly quartz gold of a good quality, as high as $20 per ounce being paid for some of it. The greatest vertical depth attained in the mines does not exceed much over 200 feet.

THE MANCHESTER MINE

Consists of a full claim of 1,500 by 600 feet. The vein courses northeast, dipping to the southeast, with a width of from 2 to 10 inches, between a slate hanging wall and a serpentine foot wall. There are two tunnels on the claim, 60 feet and 100 feet long, reaching a vertical depth of 37 feet and 75 feet, respectively. A shaft sunk 27 feet below the tunnel level has been drifted from about 30 feet. The company owns sufficient timber on their property for mining purposes. They intend to sink their incline shaft deeper, and to continue the main tunnel 100 feet farther on the vein.

THE LAST CHANCE MINE.

The property contains several veins, striking and varying in width from 10 inches to over 3 feet. Like the above, the walls are slate and serpentine. It is opened through tunnels and a shaft; the shaft has reached a depth of 160 feet. The upper tunnel reaches the shaft in a distance of 145 feet and was run in rich ore, which has been stoped out to the surface from 2 to 3 feet wide. At a depth of 124 feet the second tunnel reaches the shaft in 360 feet and extends beyond 120 feet. The two tunnels are connected by an upraise, from which drifts have been run into the ore shoot. On the opposite side of the main shaft an upraise has been made about 100 feet distant, and part of the ground stoped out. Several winzes have been sunk below the main tunnel and some underhand stoping done. Seven ore shoots are known pitching to the northeast. The timbering in the mine is done with redwood, which grows in the vicinity. The ore is run directly into the mill, which contains a 5-foot Huntington with a Frue concentrator, Huntington ore crusher, Hendy self-feeder, 11-foot apron, and 20 feet of 12-inch sluice plates, the whole run by a twenty horse-power engine. The sulphurets, amounting to 2 per cent, are mostly copper sulphides. The mine is in Sec. 26, T. 24 S., R. 4 W., M. D. M.

THE QUEEN MINE.

The vein in this claim is incased in slate, striking northeast, and dipping to the west at an angle of 45°. There are three tunnels on the claim, one 16 feet, another 70 feet, and the third 40 feet; all of them run in the slate. The vein shows a width of 10 inches.

THE KING MINE.

The vein courses southeast, dipping at an angle of 40°, with an average width of 1½ feet, between slate walls. There are two tunnels running to the north, and three shafts on the claim. The tunnels are 100 and 150 feet in length. The greatest vertical depth attained is 100 feet. The deepest shaft is 130 feet on the incline; about 60 feet in length on the vein has been stoped. An arrastra 12 feet in diameter, run by a 36-foot overshot wheel with 2-foot breast, is used to crush quartz.

Good mill sites can be obtained between these mines and the ocean, but more active work and larger developments must be made before any mill of size will be required. The showing made at present, when taking the inaccessibility of the camp into account, is not sufficient to induce capital to invest to any great extent.

South of this camp, not far from the line of San Luis Obispo, are some quicksilver prospects.

NEVADA COUNTY.

By J. B. Hobson, E.M., and E. A. Wiltsee, E.M., Assistants in the Field.

In the last report of the State Mineralogist may be found a description of the geographical and geological features of this county, with an account of its climate, soil, rainfall, resources, etc.

While other industries are engaged in to a considerable extent, and are the source of considerable revenue, that of mining is, and always has been, the chief industry and source of wealth in the county; and upon it all other industries are somewhat dependent.

The production of gold, since its discovery, has been enormous, Nevada County easily leading among the counties of the State.

No veins containing silver, to any appreciable extent, have been found. Gold mining is divided into three great branches, all of which have been pursued to a remarkable extent and with most profitable results, as follows: Quartz or vein mining, hydraulic mining, and drift mining. Of these the two latter may be said to have had their origin, and to have been conceived and developed, in this and the neighboring county of Placer.

QUARTZ MINING.

Gold, in placers, was discovered in Nevada County in 1849; in 1850 gold was first discovered in quartz on Gold Hill, adjoining the town of Grass Valley, and the first quartz mining in California was inaugurated immediately after. The first stamp mill, for the reduction of fine gold from the ore, was erected in the adjacent Boston Ravine. From the first mill, a rude affair constructed of logs, whose stamps were tree trunks and were shod with pieces of iron, the evolution of the stamp mill into the perfect mechanical device in use to-day has been rapid and effectual.

The development of the quartz industry has been wonderful in extent, and a great source of revenue to the State at large. For the first ten years after 1850 the growth was slow, as the rich placers with which the county abounded still held out, and the extraction of gold therefrom was a process requiring neither skilled labor nor machinery. In 1855 the State Geologist reported upon but seven quartz mines; of which number three were in Grass Valley and four in Amador County. It is a noteworthy fact that of these three mines, two, the North Star and the Empire, have been worked, with some interruptions, to the present time, and are being worked profitably to-day, after having produced several millions apiece.

Upon the exhaustion of the richest placers, attention was at once turned to quartz mining. Since the inauguration of quartz mining, Grass Valley has never been without dividend-paying mines, and the industry has been increasing steadily in magnitude until the present day. It is estimated that in the neighborhood of $100,000,000 in gold

bullion has been produced from the quartz mines of the district, which have surpassed those of every other portion of the country in the free-milling characteristics of the ore and in the continuity and permanency of the rich pay shoots in depth.

Nevada City District easily comes second to Grass Valley in this branch of mining. The first discovery of gold quartz here followed closely upon that in Grass Valley, occurring in October of the same year, 1850. The early days of the industry in Nevada City produced nothing but failures, due to inefficient machinery, methods of extraction, and treatment. Since that time, however, many valuable paying mines have been opened up, and the last few years in particular have shown a great revival both as to the number of properties worked and the successful and profitable results obtained.

The veins of the Grass Valley District are small; the majority averaging not over 18 inches to 2 feet in size. The Grass Valley ores are free-milling to a high degree, the sulphurets contained averaging but 3 to 4 per cent, and from 90 to 95 per cent of the gold contents being recovered in the shape of free gold.

The Nevada City veins are larger than those of Grass Valley, varying in size from 2 to 10 feet. They are much more highly mineralized, and the gold contained is more intimately combined with the sulphurets, through which it is disseminated.

The veins of the Willow Valley portion of the Nevada City District are somewhat smaller in size, but usually of higher grade than those of the remainder of the district. The developments of the past year have proved conclusively that Willow Valley is a profitable and reliable district, and have stimulated prospecting and development in that region.

In the Washington District, along the upper part of the South Yuba, the quartz veins are much larger in size than in any other portion of the county. The veins upon which operations are being conducted at present will average from 4 to 10 feet. The number of veins exposed is large, and prospecting and developing during the last year have been very successful and of a most encouraging nature. The ores of this district are free milling, and the percentage of mineral and resultant concentrates very low, the average being about one half of one per cent.

The Columbia Hill District lies along the Middle Yuba River; the veins are large, and in some instances of remarkably high grade. Considerable prospecting is being carried on, with encouraging results. It is only within the last few years that attention has been paid to quartz development, the district lying in the most valuable and profitable section of the hydraulic mining industry, on the border of the San Juan Ridge. On the divide between the South Yuba and Middle Yuba, in the neighborhood of Graniteville, successful operations are being carried on.

The Meadow Lake District lies near the summit, upon the western slope of the Sierra, and at an altitude of almost 6,000 feet. The veins of this district are of good size, excessively rebellious, and no operations are being carried on at present.

The quartz mines of Nevada County have a long and successful record; operations continued through many years have proved conclusively the permanence and reliability of the veins and pay shoots, and the free-milling properties of the ores have rendered their reduction and the extracting of the valuable contents economical and complete.

The many improvements in methods of mining and milling have ren-

dered profitable the working of many mines which, in early years, could not be carried on at a profit, and altogether there is a most inviting field for judicious investment with the prospect of ample and sure returns.

HYDRAULIC MINING.

Gold mining in California during the first few years after the discovery of gold in 1848 was confined to the rich and shallow placer diggings in the ravines, the dirt being washed in a pan, a rocker, or a long-tom. In a short time sluicing was practiced as a far more convenient mode of extraction. In Nevada City, in 1853, the advantage of a stream of water directed against a bank of earth was first discovered and demonstrated, and hydraulic mining as an industry immediately assumed great importance.

Miles of country from which the gold could be profitably extracted by no other process, became immediately available for hydraulic mining. The ancient river channels, which are frequently entirely uncovered and which from the effects of erosion often occupy high benches of ground, thus giving an opportunity for dumping gravel and profitable working, have furnished the great seat of operations in this industry.

Nevada County from the first led the rest of the State in hydraulic mining. The San Juan Ridge, 25 miles in extent, contains an ancient river channel, varying from 1 to 1½ miles in width. The depth of gravel is in places as much as 300 feet. This entire channel is a succession of great hydraulic mines, the North Bloomfield Mine having been for years, and up to the prohibition of the industry, the greatest hydraulic mine in the world.

Bridgeport, Bloomfield, Nevada, and Little York townships were the scenes of the greatest activity in the industry, the leading camps outside of the San Juan Ridge being Dutch Flat, You Bet, Quaker Hill, Nevada City, Remington City, and Blue Tent.

Since 1884 the industry has been suppressed, with a loss to the State and country at large, from this county alone, of many millions per annum.

DRIFT MINING.

Where a great depth of capping or non-paying material has been placed upon a channel of pay gravel, or where the valuable contents of a deep gravel channel have been so concentrated in the lower or bedrock strata as to render the main portion of too low grade to admit of profitable working by the hydraulic method, drift mining is resorted to. Drift mining is thus the process of tunneling and breasting, by which comparatively shallow strata of gravel are extracted without the removal of the deep top covering, either of poor gravel or valueless capping. The gravel extracted by this method is usually cemented, necessitating the use of mills for reduction; sometimes, however, it is "free," when the valuable contents can be removed by sluicing. This form of mining may be considered to have had its origin in Nevada County, in which, and in the neighboring county of Placer, it has been employed to a large extent.

An especial stimulus has been given to drift mining since the prohibition of hydraulic mining, and attempts have been made to work some of the great channels by this method. In almost every instance, however,

this has been found impossible, from the fact that only in rare cases have the valuable contents been found sufficiently concentrated in any stratum to admit of profitable extraction by this more expensive method.

The chief application of drift mining is found in the case of shallow but rich channels of gravel, which have been heavily covered with "top dirt," or capping; usually in this county the result of a lava flow and consequent change of channel. The ancient river systems of Nevada County are numerous and interesting in many particulars. The size of the streams has varied greatly, from small tributaries a few feet in width up to the great stream whose bed lies upon the San Juan Ridge, and which left as an evidence of its existence and might a bed of gravel 500 feet in depth and varying in width from 1 to 1½ miles; far surpassing anything in this portion of the State at present, and almost, we might say, in the State at large. The general flow of these rivers seems to have been much in the direction of the present ones; from their size and large number it would seem most probable that they had drained a far greater watershed than that from which the present streams derive their source of supply. That they were of different systems is evident from the fact that in some instances one channel has been found to cover a second many feet above the latter. The question of their age is a disputed one, the various authorities being unable to come to any agreement in this regard; they are usually assigned, however, to the Pliocene epoch of the Tertiary. The obliteration of their ancient beds has been due to two causes: First, the gradual erosion produced by the later river following the same course as the old one, and thus cutting down the old bed, often under the influence of steep grades; and second, the erosion of the earth's surface and consequent removal of the bed, where from natural conditions it had escaped destruction from the first cause.

From these two causes it is evident why fragments only of the original channels remain. From the effects of erosion during subsequent ages these channels are in most instances to be found occupying more elevated positions than the neighboring streams of to-day. The same convulsions of nature which were probably instrumental in aiding the elevation of the Sierras, produced an enormous flow of lava, which covered a great portion of the upper part of this and the neighboring counties to the depth of hundreds of feet; by this means the original channels were buried, and the direction of the watercourses diverted, with a result that the old channels are now found covered many feet deep with a covering of volcanic "top dirt."

The gravels in some instances are composed largely of quartz, and in other cases of diabase, diorite, serpentine, slate, and kindred rocks. In any case, the lowest, or hard cemented, gravels are colored blue, from the peroxide of iron contained, the ferrous form being produced doubtless by the reducing action of organic matter accompanying the stream upon the more oxidized iron salts.

The last year has been productive of very important and successful results in drift mining, especially in the neighborhood of Nevada City. The rich channel in the Washington Ridge, overlooked since the later 60's, has been found and intersected in several places, with the result that gravel of very high grade has been met with in each instance. A great deal of development work is in progress at date, and a very suc-

cessful and profitable revival of this industry is taking place in this neighborhood.

At Mooney Flat, on the western border of the county, the lower and harder cement strata of the Timbuctoo channel have been successfully worked by the drift process. At this point and the neighboring workings in Sucker Flat, in Yuba County, the reduction of the hard cement is effected by arrastras, this process proving superior to the ordinary method of crushing in stamp mills, from the far greater capacity and consequent low cost of reduction. Equal efficiency in the extraction of the gold is claimed.

At You Bet and Hunt's Hill drift operations are being prosecuted to some extent.

In the North Bloomfield District the Derbec Mine is still producing largely, prospecting operations pointing to a future era of prosperity.

At Remington and Lowell Hills prospecting is being carried on, but no large working force is reported.

Upon the whole, the drift mining industry has received a large impetus during the year, due largely to the result of operations in the neighborhood of Nevada City.

GEOLOGY AND WATER SUPPLY.

As to the geology of this county, reference is made to the last report of the State Mineralogist (1890).

Nevada County possesses a complete and extensive system of canals, used in connection with the abundant supply of water stored in the natural and artificial reservoirs near the summits of the Sierras. In the State Mineralogist's Report for 1890, pages 393–397, will be found a complete description of the various ditches, canals, and reservoirs of the water and mining companies.

The five leading ditch companies of Nevada County have a joint ditch system 640 miles in length, with a carrying capacity of 23,000 miner's inches of water. This entire supply was formerly profitably used in the hydraulic mines; to-day, less than 25 per cent is used for any purpose. The total first cost of this water system was in the neighborhood of $5,250,000.

GRASS VALLEY MINING DISTRICT.

The Grass Valley District is the oldest, best known, and most reliable and prosperous quartz mining district in California. Quartz mining began with the discovery of gold quartz in Gold Hill, in the year 1850, and has continued with unabated prosperity up to the present day. The ore is, in most cases, a well-ribboned quartz, containing in addition to the disseminated free gold, a considerable percentage of pyrite, with galena, chalcopyrite, and blende in smaller quantities. The gold is heavy, frequently very coarse, and of a nature easily recovered in the mills; when inside battery plates are used the percentage recovered in the battery varies from 65 to 90 per cent of the free gold contents. The percentage of pyrite and accompanying minerals varies from 1 to 5 per cent; the resultant concentrates are of good grade, running from $50 to $300 per ton, and are usually sold to the neighboring chlorination works. Of the total available contents of the Grass Valley ores, a very

large proportion, 90 to 95 per cent, is recovered in the shape of free gold, the remaining 5 to 10 per cent being in the concentrates.

The geology of the Grass Valley District is quite varied, the principal mines occurring in three distinct formations, each of which contains valuable and profitable properties. The two principal formations are the diabase, in which the majority of the mines occur, and the syenite, which merges into quartz diorite, coming next in the amount of territory covered. Just north of the town of Grass Valley a narrow belt of serpentine, varying in width from one quarter to one mile, crosses the country, striking a little to the north of west and south of east. The Eureka Mine, long since worked out, and the Idaho, with the Maryland as its future successor, are the only mines of prominence that have been found in this serpentine belt. The Idaho vein lies between a foot wall of gabbro, with a diorite hanging wall. The Idaho has a greater record of production than any mine in the district, with its lowest workings at a depth of 2,000 feet vertical.

North of the serpentine belt the formation changes to a diabase, followed by a narrow belt of true slate along the south slope of the Town Talk Ridge, which divides the Grass Valley and Nevada City districts. In this slate formation the Merrimac Mine is situated. On the summit of the ridge the diabase again comes in and extends north until its junction with the syenitic granite, which makes its appearance, strikes by a second narrow belt of slate, south of Nevada City. At all points to the south of this serpentine belt the country is divided between diabase on the one hand, and syenite, changing frequently to diorite, on the other; no true slate can be said to have been found.

The syenite belt comes up the county from the south, the junction between it and the diabase skirting along the base of Osborn Hill. Turning a little toward the east it follows up Little Wolf Creek to a point west of the Empire Mine, circles around to the north, passing through the town of Grass Valley, turns west again around the base of Gold Hill, and follows south along the west bank of Wolf Creek. The formation east and west of this syenite belt, which varies in width from a mile to a mile and a half, may be said to consist of diabase entirely, with narrow belts of hornblendic schists and aphanitic diorite in places.

In the syenite belt, which as before stated merges into quartz diorite, the Omaha, Hartery, Wisconsin, and Pennsylvania Mines are at present working—the once famous Allison Ranch Mine also lying in this formation. The Empire and W. Y. O. D. Mines contain both formations; the Empire south drifts, in the lower levels, being in diabase, and the north in diorite. The W. Y. O. D. passed through diorite in its upper workings, and is at present wholly in diabase in the bottom. The North Star, New Ruby Bar, New York Hill, Hudson Bar, Peabody, together with the Osborn Hill group of mines, lie entirely in the diabase; hornblendic schists being sometimes met with. The Brunswick Mine, southwest of the Idaho, has a foot wall of chlorite schist, a formation which is found, at times, in the footwall of the Idaho, with a hanging wall of argillaceous talc.

The noteworthy features of the Grass Valley veins are the reliability and permanence of the rich pay shoots in depth, and the high grade and free-milling properties of the ores. The mining industry has been in a prosperous and flourishing condition since its inauguration in

1850, a record equaled by no other camp in the State. As examples of this permanence of the mines, three—the North Star, Empire, and Idaho—are at present working at depths of over 2,000 feet upon the incline. The North Star Mine has the greatest depth on the incline, 2,800 feet; the Idaho has the greatest vertical depth, 2,000 feet.

W. Y. O. D. MINE.

This mine is situated in Mary's Ravine, on the west slope of Ophir Hill, one mile west of Grass Valley, at an altitude of 2,500 feet. The dimensions of the property are 1,500 by 600 feet; the average width of the vein is 15 inches. The formation varies in different portions of the mine and in depth; the contact between the syenite and diabase formations crosses the property. The upper level lies entirely in diorite; as depth is attained, the foot wall changes to a diabase, the hanging wall still continuing to be syenite. A narrow body, or dike, of syenite then cuts vertically through the workings and into the foot wall; this dike is but 75 feet wide. After this is passed through, the formation changes to a diabase in both walls.

The property is opened by an incline shaft, with a drain tunnel to carry off the surface water. The shaft is 890 feet in depth, with an average inclination of 32° from the horizontal, and is close-timbered for 200 feet. The drain tunnel is 600 feet in length, and intersects the shaft at a point 126 feet from the collar, or 70 feet vertically below the surface. There are eight levels run from the shaft.

There are two ore shoots so far opened, with every prospect of a third being found farther to the south. The main shoot lies near the shaft in the central portion of the ground, and the main workings are upon this shoot; the second shoot lies farther to the north and has been penetrated by the No. 2 level, none of the lower ones having yet been extended into it. The main shoot varies in grade, length, and width in the different levels; it has increased wonderfully in all these three characteristics as depth has been attained, and on the 800-foot level has been opened by the drifts for a length of 360 feet, with the vein still strong in the breasts of both drifts. The shoot tends slightly to the south as depth is attained.

The shaft has three compartments, with dimensions 16 feet by 5 feet in the clear. The sinking costs $20 per foot for labor. Spruce timbers are used throughout, and cost 6 and 8 cents per running foot for poles 6 and 8 inches in diameter at the small end.

The pumping system contains three pumps—a 10-inch and a 7-inch plunger, and a 6-inch lift pump for sinking. The pumps are only run four strokes per minute, and about 70,000 gallons are pumped from the mine every twenty-four hours. Safety Nitro No. 2 is the explosive used. The cost of extracting ore is $4 per ton.

Ventilation is supplied by a vertical air shaft, 200 feet south of the main shaft, and 80 feet in depth, connecting with the first level.

The ore is free-milling ribboned quartz, containing pyrite, galena, and blende, in addition to free gold. It is treated in the ten-stamp mill, situated close to the hoisting works. The stamps weigh 750 pounds each, and drop 7 inches eighty-five times per minute. The ore is crushed through a forty-mesh brass wire screen, and the stamps have a capacity of 1½ tons each per twenty-four hours.

The plate run is a large one, the apron plates being 4½ by 4 feet, and the sluice run 4 feet wide and 16 feet long.

The concentrates are saved on four Frue tables; the ore contains 4 per cent of sulphurets, the grade running from $90 to $240 per ton.

In addition to the mill already described, the plant contains a large and commodious hoisting works, with powerful hoisting and pumping machinery. The pumping is done by a 16-inch horizontal engine; a 10-inch engine does the hoisting. The mill also is run by steam, a 10-inch engine doing this work. The boilers, three in number, 48 inches in diameter and 16 feet long, supply the steam for the entire plant. Five and one half cords of wood are used per day, costing $4 per cord.

During the past year the company has put in extensive improvements, costing $50,000, all of which has been paid out of the mine in addition to the dividends declared. The improvements consist of heavy pumping and hoisting plant, ten-stamp mill, additional boiler, etc. Underground the shaft was widened from a two to a three compartment and heavy T rails laid throughout.

The following development work was done underground during the year: The shaft was sunk over 200 feet; the entire 800-foot level run; the 700-foot level north extended 100 feet; the south drift 110 feet. The 600-foot level north and south, the 400-foot level south, and the 200-foot level north were also extended considerable distances.

At the time of visit a total of fifty-five men were employed, divided as follows: In mill, five men; on top, ten men; underground, forty men. Miners' wages, $3 per day.

NORTH STAR MINE.

The well-known North Star Mine is situated 2 miles south of Grass Valley, on the Auburn road, on what was formerly known as Lafayette Hill. The property is an extensive one, and was fully described in the last report.

The underground workings of this mine are most extensive. The mine is opened by an incline shaft, with dimensions of 16 feet by 5 feet. The total depth of the shaft on the incline at date is nearly 2,800 feet. This is the deepest mine, measured on the inclination of the vein, in the county, and without doubt in the State.

Twenty-three levels are turned from the shaft, extending west of the shaft a maximum distance of 900 feet, and east 1,400 feet.

A drain tunnel, intersecting the shaft at a vertical depth of 50 feet, relieves the mine of its surface water; this drain tunnel is 2,500 feet in length.

The cost of sinking the shaft has varied greatly at different times; it has been as high as $26 per foot for labor alone. A run made in favorable ground with machine drills gave the large total of 55 feet for one month's work, the total cost for labor and supplies being but a little over $10 per foot.

There are two main shoots of ore worked, one east and one west of the shaft; their combined length is about 1,000 feet, the main shoot being on the left of the shaft. The trend of the ore shoot is about vertical, with a tendency, if anything, toward the west.

The mine makes a large amount of water—18,000 gallons per hour, during the summer months. To handle this amount, a heavy pump

system with large pumps is necessary. Two of these pumps are 16-inch plunger pumps, working on 6-foot stroke and running, in summer, four to five strokes per minute. In winter there is a large increase.

Machine drills are used underground for dead work alone; stoping is done entirely by hand, this method proving advisable and economical, on account of the small size of the ledge, which does not average more than 17 inches. Phœnix and National drills are used, power being supplied by the Risdon Iron Works compressor. Safety Nitro No. 2 powder is the explosive used. Spruce poles, costing from 6 to 10 cents per running foot, according to size, are used. Timber is delivered for $17 per thousand feet.

The mine has an excellent and extensive surface plant. The hoisting works are of large size, containing a large and powerful set of hoisting drums, capable of working to a great depth. Blacksmith, machine, and carpenter shops are also in the same building.

A steam plant, with large boiler capacity and powerful 16-inch engine, is kept in readiness for use in case of failure of water supply for any cause.

The entire hoisting, pumping, and milling plants are run by water power. Pelton wheels are used, the power—water—being delivered under 240-foot head in the hoisting works, and 280 feet in the mill. A total of 400 inches is used, costing 18 cents an inch.

The ore is a free-milling quartz, containing, in addition to free gold, about 5 per cent of mineral, consisting largely of pyrite, with traces of galena and blende. The sulphurets are not high grade, running from $30 to $60 per ton. The ore is crushed in an admirably arranged and well-equipped forty-stamp mill; the stamps weigh 850 pounds, drop 7 inches eighty-six times per minute, and crush through thirty-mesh brass wire screens. About 2 tons per stamp are crushed in twenty-four hours. Chrome steel shoes and dies are used, and the ore fed in Challenge feeders. The sulphurets are saved on twelve Triumph and four Frue concentrators.

A total of one hundred and twenty men and boys is employed. Miners' wages, $3 per day.

During the year 1891 nearly 22,000 tons of ore were milled, and over 900 tons of concentrates produced.

IDAHO MINE.

The noted Idaho Mine is situated on the south side of Wolf Creek, 1 mile east of Grass Valley, at an altitude of 2,450 feet. The property comprises 3,100 feet on the Idaho vein, and a large tract of land on both sides. The course of the vein is east and west, with a dip to the south at an angle varying from 55° to 73°. The ore shoot trends rapidly to the east at a slight angle.

Since the last report the incline has been sunk 200 feet, sinking being in progress below the twentieth level. The operations of the past year have been confined for the most part to the ore shoots developed in the lower workings of the mine.

Since the issuance of the last report a large amount of dead work has been done in the way of shaft sinking and drifting.

At present, work is being prosecuted in the bottom levels, and upper levels on the main shoot.

When visited, thirty stamps were dropping on ore. The percentage of sulphurets in the ore from the deep workings is much larger than that from the ore in the main shoot.

The mill contains forty stamps, of which thirty were in use. The stamps weigh 850 pounds, drop 7 inches seventy times per minute, and crush through forty-mesh steel wire screens. The capacity per stamp is 2 tons per diem. The concentrates are saved on ten Frue and Triumph concentrators; the latter have the Blasdel improved belt.

The Idaho is the deepest gold mine in the State of California, if not in the United States. Its present lowest workings have a depth of nearly 2,100 feet, with the sinking of the shaft in progress.

During the year 1891, 16,700 tons of ore were produced and milled, and about 160 tons of concentrates made.

EMPIRE MINE.

The Empire Mine, the property of the Original Empire Mining Company, is situated on Ophir Hill, 1 mile southeast of the town of Grass Valley. The mine having been fully described in the last report, mention will only be made here of developments effected during the past year. This work has been concentrated upon two separate parts of the mine; the first, in the lowest portion of the mine, upon the main pay shoot in depth; the second, the opening up and development of what is known as the "Rush and Laton shoot," lying farther to the south and nearer the surface. The development in the lower workings during the year 1891 consisted in the following operations: The main incline shaft was sunk 200 feet, the depth at present being 2,100 feet, and the vertical depth attained 900 feet. The station at the 2000-foot level was cut, and a crosscut started toward the foot wall to intersect the middle and foot wall ledges. On the 1800-foot level the north drift was advanced 200 feet, and the south drift 200 feet. The north drift on the foot wall ledge was also advanced 225 feet, and the winze from the 1800-foot level south drift sunk 240 feet. On the 1700-foot level the south drift was advanced 380 feet, and a raise sent up 225 feet; crosscut for the Rich Hill or hanging wall vein advanced 240 feet.

The result of development in the lowest levels is gratifying, indicating, as it does, that the theory held by Mr. Starr, the Superintendent, and in accordance with which development for several years past has been directed, is the correct one.

At the 1300-foot level the vein splits into three portions, one going far out into the hanging, the second pursuing a middle course, and eventually proving to be the main vein, and the third falling back into the foot wall. This separation into three veins did not take place throughout the entire course of the vein, but was local, the division only extending about 200 feet south of the shaft, and running across several hundred feet upon the north side.

This rupture occurred in the main pay shoot of the mine, and the gold contents seem to have been distributed through all the three veins. While in the shoot above the point of division the ore was of excellent grade, the dissemination into three parts produced veins whose grade would scarcely yield a profit. The entire development and exploration of these lower levels have been done upon low-grade ore and were only possible through the excellent management and judgment shown

throughout. The middle of the three veins has proved the main one, the back, or foot wall vein, dipping very flat below the 1800-foot level and rapidly coming out to fall into it.

A noteworthy fact is, that on the northern edge of the divided zone these two veins again unite on the 1800-foot level at a point under where they were separated in the upper level, and under a point where the shoot was rich in the upper levels before their separation. Their union was immediately marked by a recurrence of the high-grade ore, of identical character with that found above.

The Rush and Laton shoot, which had been untouched for twenty-five years, and had never been explored by this company, was also opened up, with the most gratifying results, during the year. The shoot is upon the same vein, lying farther to the south, and having a very rapid trend to the south. It had been worked down less than 200 feet from the surface when abandoned. The old workings were pumped out and explored from the surface, and it was at once discovered that the ore left in sight was of high grade. Connection has now been made with the main workings of the mine by means of a raise from the 600-foot level. The old drifts were extended and an intermediate drift driven 350 feet. The ore shoot is at date 200 feet in length, with pay ore still in breast of drift. The vein averages one foot in size, the ore being high-grade and free-milling, heavily mineralized with pyrite and galena in addition to free gold disseminated throughout, the sulphurets having a value of $150 to $200 per ton. The intermediate drift is being extended to cut a second shoot still farther to the south, which outcropped rich on the surface. Twenty miners are at present employed in this Rush and Laton workings, the ore extracted having averaged in the neighborhood of $35 per ton in free gold.

Men are now at work exploring a hanging wall vein in the Magenta, or north end of the property, with the intention of developing an ore shoot at that point.

During the year 1891, 17,320 tons of ore were milled and 388 tons of sulphurets produced.

OMAHA CONSOLIDATED MINE.

The Omaha Mine is situated on the west bank of Wolf Creek, 2 miles south of the town of Grass Valley, at an altitude of 2,310 feet. The property is a consolidation of the Omaha and Long Jack Mines, and has an extent upon the lode of 2,600 feet. This property was fully mentioned in the last report, and reference will be made here only to developments and improvements since that time.

The mine is opened by two incline shafts situated on the vein, and distant from each other 800 feet. The various levels are connected throughout, ore and waste being hoisted from both shafts. In all, thirteen levels have been run from the main, or Omaha, shaft. During the year 1891 the following development work was completed: The Omaha, or northern, shaft was sunk 220 feet, making a total of 930 feet; the Long Jack, or southern, shaft was sunk 217 feet, making a total of 915 feet; the No. 7 south Long Jack drift was run 50 feet, giving this level a total length of 1,865 feet through the workings; the No. 10 south Omaha drift was advanced 195 feet, and the No. 10 north Omaha, 140 feet, giving this level a total length of 2,002 feet throughout; the No. 11 north Long Jack drift was advanced 276 feet; the No. 11 south Omaha, 14 feet, and

the No. 11 north Omaha drift, 70 feet; the No. 12 south Omaha drift was run 163 feet; the No. 12 south Omaha drift, 500 feet, and the No. 12 north Long Jack, 27 feet; the No. 13 south Omaha drift was run 200 feet.

The ventilation of this mine is far superior to that of any of the other large mines of the district. The collar of the Long Jack shaft is about 80 feet higher than that of the Omaha shaft, the ground rising rapidly in that direction. The result is a strong current of air throughout the mine at all time, passing down the Omaha shaft, through the lower levels, and up the Long Jack incline.

Since the last report was issued, ten stamps have been added to the Omaha mill, a total of twenty-eight being now employed in crushing the ore from the mine. The stamps weigh 900 pounds each, drop ninety-five times per minute, and crush through forty-mesh brass wire screens. Four plain belt Frue concentrators have been added to the four improved belt machines already in place. The capacity of the stamps is 1½ tons to the stamp per diem. About 30 tons of high-grade sulphurets are produced per month.

During the last year between 8,000 and 9,000 tons of ore were milled and 360 tons of sulphurets produced.

The plant is now of the best description and has all the latest improvements.

BRUNSWICK MINE.

This mine is situated 2½ miles east of Grass Valley, on Union Hill. The property contains 37½ acres, and has an extent upon the lode of 3,300 feet. The average width of the vein is 2 feet. It lies in a contact fissure, the hanging wall being a hard argillaceous talc, while the foot wall is a chloritic talc-schist. The foot wall is almost identical with that which forms the foot wall casing of the Idaho vein at times.

The mine is opened by an incline shaft, with a drain tunnel to relieve it of surface water. The drain tunnel is 420 feet in length, and meets the shaft at a point 165 feet from the surface. It is close timbered the entire distance. The incline shaft has a depth of 610 feet. Four levels are run from it.

Stoping is now being carried on from the No. 5 level, at a depth of 600 feet. The shoot has increased in grade and quality as depth has been attained upon it. The shaft is now in excellent ore, this change coming in at a depth of about 400 feet upon the incline.

The pumping system consists of one 8-inch and one 6-inch lift pump, the 8-inch at the third level and the 6-inch on the bottom. About 50,000 gallons of water is pumped from the mines in twenty-four hours.

Safety Nitro No. 2 powder is the explosive used. Timbers are all cut from the company's property. The dimensions of the shaft are 14 feet by 6 feet in the clear down to the 265-foot level; from this point to the bottom it is 10 feet by 6 feet. The cost of sinking is $12 10 per foot, including both labor and supplies. The ore is banded ribbon quartz, containing good grade sulphurets in addition to free gold; the sulphurets consist of pyrites and galena.

The ore is treated in the company's twenty-stamp mill, situated about 600 feet from the hoisting works. The company has recently constructed 285 feet of tramway from the end of the dump to the mill. The rock-breaker has been situated so that grizzlies could be put in, and the

batteries fed by self-feeders. Four Frue concentrators have been put in the mill, and everything pertaining thereto thoroughly renovated and overhauled. These improvements have been lately completed, and the entire surface plant is now well arranged and in first-class working order.

The plant upon the property consists of hoisting and pumping works, and a twenty-stamp mill. The hoisting works are provided with water power, under a head of 320 feet, from the Grass Valley Water Company's pipe-line. All pumping and hoisting is effected by water power, a total of 19 inches being used, at a cost of 25 cents per inch. The stamps weigh 950 pounds each, and drop 6 inches eighty-five times a minute. The ore is crushed through forty-mesh brass wire screens. The apron plates are 4 feet wide and 5 feet long, with a double sluice run 10 feet in length. The duty per stamp is 2 tons in twenty-four hours. The concentrates are saved on two Frue tables. The mill is run by steam, a 10-inch horizontal engine furnishing the power. Two and one half cords of wood are required to run ten stamps every twenty-four hours.

The ventilation of the lower workings of the mine is effected by an ingenious device designed by Mr. Fitzgerald, the Superintendent. The water column is tapped at a depth of 300 feet from the surface, a 1½-inch pipe set in, and the power thus obtained applied to a Pelton wheel driving a fan. Ventilation above this point is good, being effected by means of a raise and air shaft to the surface.

At present ten stamps are being dropped on ore. Six men are employed underground, two men on surface work, and two men in the mill. Miners' wages are $3 per day.

PEABODY MINE.

This mine joins the townsite of Grass Valley on its eastern boundary. It has an altitude of 2,450 feet. The course of the vein is a little west of north and east of south, dipping east at an angle of 33°. The vein varies in size from 1 to 2 feet, with an average width of 18 inches. The inclosing formation is noteworthy, the foot wall being a hard dike of rock closely resembling diorite, differing from it only in that the hornblende contained is fibrous instead of semi-crystalline or granular; the hanging wall varies little from the foot wall.

In the hanging wall, striking at right angles to the course of the vein, is a peculiar dike, which abuts against the vein, but does not penetrate the foot wall. This formation is rock closely allied to felsite, composed of feldspathic material containing granules of feldspar. It contains considerable pyrites disseminated through it, and would seem to have enriched the vein when in its proximity.

The mine is opened by two incline shafts sunk on the vein 600 feet apart. The main, or north, incline is connected with the south, or old, incline on the first, second, and third levels, and all ground between the two shafts and above this 300-foot level has been stoped out. The south or old incline has a depth of 250 feet, and is used at present as an air and auxiliary pump shaft. The north incline is an excellent, large shaft, the dimensions being 16 feet by 7 feet over all; it is well timbered with heavy sawed spruce, and divided into three compartments: one 6 feet by 4 feet, for pumping, and two small hoisting compartments. The total cost of sinking this shaft, in hard ground, at present, is about $24 per foot, including labor and supplies.

Four levels are turned from this main incline, as follows: The first, 150 feet from the surface, extends south 430 feet, and connects with the south incline, extending north from the main shaft 240 feet; the second, 100 feet lower, extends south 370 feet, and also connects with the old shaft, running north from the main shaft 105 feet; the third, 50 feet lower, or at a depth of 300 feet, runs south 265 feet and north 24 feet; the fourth, or lowest, at a depth of 400 feet on the incline, runs south 110 feet and north 20 feet. The shaft is sunk 30 feet under the fourth level. There is one ore shoot 700 feet in length. The greatest length of ground stoped is over 600 feet. The ground already stoped is as follows: From the 300-foot level to surface between the two incline shafts, the 400-foot level thus giving 100 feet of "backs" between those points; from the 150-foot level north of main incline to surface; all ground north of shaft and below this level being untouched. South of the old incline no work has been done. The 400-foot level south drift is at present in from the shaft 110 feet, in ore all the way, the vein averaging a foot in size.

Sixty feet south of the shaft is a raise to the 300-foot level, and stoping from the raise is in progress.

The 400-foot level north drift is in 40 feet in ore, the vein averaging a little under one foot, but of good ore.

This mine has recently produced wonderfully rich specimens; the general run of the remaining ore is also said to be of good grade.

A 12-inch plunger pump handles the water with ease, raising it to the drain tunnel, which intersects the main incline 55 feet from the surface. About 25 inches of water is raised from the mine, the pumps elevating over 200,000 inches daily. Giant No. 3 powder is the explosive used.

The character of the ore is well-ribboned quartz, carrying heavy, coarse gold disseminated through, and showing at times extremely rich specimen ore.

There is a substantial hoisting and pumping plant upon the mine; a 12-inch horizontal engine does the pumping, and an 8-inch engine the hoisting. A 50-inch by 16-foot boiler generates the necessary power.

The ore is at present hauled to a mill about one eighth of a mile distant. The mill is not owned by the company, the ore being reduced by contract.

The system of ventilation in the mine is excellent, the two shafts providing an ample current of air unaided. Nine and one half cords of wood per diem suffices for pumping and hoisting, costing $3 to $3 50 per cord.

Thirty men are employed underground, five men on surface work, and four in the mill. Miners' wages are $3 per day.

PENNSYLVANIA MINE.

The dimensions of the claim are 2,860 feet by 200 to 400 feet in width. The width of the vein varies from 4 inches to 2 feet, with an average throughout of about 1 foot. The inclosing formation is a syenite in both walls. The mine is opened by an incline shaft 440 feet in length, with the inclination varying from 14° to 38°. The dimensions of the shaft are 5 feet by 8 feet in the clear. Four levels have been run from the shaft, the lowest at a depth of 400 feet, running north 150 feet. The

present developments have revealed one shoot of ore, 350 feet in length as far as run on.

The water is very light, a 6-inch pump, on 6-foot stroke, and running seven strokes per minute for eight hours per day, keeps the mine clear of water. Safety Nitro No. 2 is the explosive used.

There is a substantial hoisting, pumping, and crushing plant upon the property, so arranged that the ore coming from the shaft is dumped directly into the ore bins. The ore is reduced in a five-stamp mill, and in character is ribboned quartz, containing pyrites and galena in addition to free gold. The stamps weigh 750 pounds each, and drop 6 inches eighty-one times per minute; the duty per stamp is 1⅘ tons per day. Chrome steel shoes and dies are used; the ore is crushed through a No. 30 brass wire screen. The apron plate is 4 feet by 4 feet 8 inches, and the sluice 18 inches wide by 12 feet long. An inside battery plate 4 inches wide is used. The ore is fed from a Hendy feeder; two thirds of the amalgam is recovered from the battery and one third on the plates. The concentrates are saved on a Woodbury concentrator. The entire plant is run by steam power, one 8-inch and one 10-inch engine furnishing the power. When everything is running full, including the mill, but one and one half cords of wood are burned per day. A large amount of work has been done during the year, including 350 feet of shaft sunk, and several hundred feet of drifts run. Eighteen men are employed.

CENTRAL NORTH STAR MINE.

This mine is situated about 2 miles south of the town of Grass Valley, at an altitude of 2,480 feet. It consists of two claims, 1,500 by 600 feet, and 1,200 by 600 feet, respectively. The property is the eastern extension of the North Star Mine. At present the mine is sinking a vertical shaft in order to intersect the extension of the North Star vein, whose course is east and west, dipping north at an angle of 20°. The formation is a diabase in both walls. The shaft at date of visit had a depth of 170 feet; its dimensions are 4 feet by 10 feet in the clear, and it is well timbered the entire distance. No levels are as yet turned. Very little water is coming in, but ten barrels per shift being hoisted. Pumping machinery is, however, all in position, and arrangements completed to put in a 6-inch pump whenever needed. Seven feet of shaft are sunk per week, at a cost for labor of $16 per foot.

The formation passed through is diabase the entire distance. The mine is equipped with a substantial hoisting and pumping plant, containing a 7-inch hoisting and a 10-inch pumping engine. One half cord of wood is consumed per day.

SLATE LEDGE MINE.

The Slate Ledge Mine is situated on Wolf Creek, 5 miles from the town of Grass Valley. The property has an extent of 1,500 feet upon the vein, and contains 40 acres of surface ground. The course of the vein is east and west, dipping south at an angle of 33°; it averages 18 inches in width. The formation throughout a greater portion of the vein is a diabase, but in the eastern portion of the ground this changes to a contact formation, the diabase underlying the vein, while the hanging wall and the country rock is a syenite, the vein turning more to the

southeast as it enters this formation. So far the workings have only penetrated 30 feet into this contact formation. The mine is opened by a tunnel on the vein about 2,000 feet in length and having its mouth on Wolf Creek, at the westerly end of the ground, running east. The cost of driving this tunnel is $50 per foot, and it is timbered for the first 1,000 feet of its length. It is in diabase the whole length, with the exception of the last 30 feet, this being in the contact. As far as developed, four ore shoots have been discovered, three having been passed through and the fourth now being encountered in the breast of the tunnel. The lengths of the shoots passed through are 60 and 400 feet, respectively, the first shoot being met 1,000 feet from the mouth of the tunnel. The dimensions of the tunnel are 5 feet by 3½ feet in the clear. The trend of the shoots is about 5° to the west, this being somewhat noteworthy, as contrary to the rules of the district. A depth of 400 feet on the inclination of the vein is attained by the tunnel at the inner end.

In the former workings of the mine, through an incline on the vein, the workings being wholly upon the main shoot, stoping was carried on to a point in depth 200 feet below the tunnel. Timber is obtained from the property for all operations.

The ore is a free-milling banded quartz, showing fine, free gold, and carrying a fair amount of sulphurets, consisting mainly of pyrites with some galena; it is hauled from the tunnel to the mill, one quarter mile distant. The ore is crushed in a ten-stamp mill, the stamps weighing 800 pounds each, and dropping 6½ inches eighty times per minute, crushing 1½ tons per stamp, through a No. 12 slot-punched screen. The concentrates are saved on three Hendy pans, and have a value of $40 per ton. The mill is now run by water, a hurdy-gurdy wheel being used. The property owns water rights, so that free power is procured.

During the past year work has been confined to the 60-foot shoots cut by the tunnel; the first has been worked down 200 feet under the tunnel level, by means of two small hurdy-gurdy wheels for pumping and hoisting, water being delivered thereon under 100 feet of head. It is the intention to reopen the old incline, put in hoisting and pumping plant, and work the whole mine below tunnel level.

By means of overshot wheels in Wolf Creek, the pump rods and hoisting rope will be carried up the bank 200 feet and down the incline, power thus being obtained free, and pumping being very light, on account of the depth of the drain tunnel.

JACK RABBIT MINE.

The Jack Rabbit Mine is situated 4 miles east of Grass Valley. The property consists of a square claim containing 120 acres, with mining claim adjoining it, and having dimensions of 3,000 by 600 feet, giving a total extent of 5,000 feet upon the vein. The course of the vein is northwest and southeast, dipping southwest at an angle of 55°. The average width of the vein is 16 inches. The inclosing formation is the same in both walls—a banded sedimentary rock, with slate and sandstone in alternate layers. The mine is opened by an incline shaft and a drain tunnel. The drain tunnel is 300 feet in length, and is timbered the entire distance. It costs $2 50 per foot for labor, and lies in soft ground; it intersects the incline at a point 65 feet from the surface.

The shaft has an inclination of 55° from the horizontal, and is 210

feet in depth; its dimensions are 5 feet by 10 feet in the clear, and it is excellently timbered its entire distance, 8x10-inch spruce timbers being used. The cost of sinking is $13 per foot. An air shaft to the drain tunnel aids ventilation. No levels are as yet turned below the drain tunnel, and the shaft will be sunk 50 feet farther before the first level is run.

The water is handled by a 6-inch pump running seven strokes per minute, and about 60,000 gallons of water per day are pumped from the mine. Judson No. 5 powder is the explosive used; timber is produced from the property at the cost of cutting, and lumber costs $16 per thousand feet.

The ore is banded quartz, containing high-grade sulphurets in addition to free gold. The country rock in both walls is heavily impregnated with pyrites. The plant upon the property consists of a roomy and substantial hoisting works. Power is furnished by a large 12-inch engine with 3-foot stroke. A 4-foot friction hoist is employed. A 50-inch by 16-foot boiler supplies the steam. The entire plant is erected in an excellent manner, the machinery running in admirable order.

This attention to mechanical details is carried into the method of hoisting and handling ore, it being economically and advantageously effected by an automatic self-dumping skip, designed by Mr. L. P. Goldstone, the Superintendent. This skip has a capacity of one half ton. Its front wheels run upon a rail laid upon the sills, and the hind wheels, placed near the upper part, upon an upper or guard rail. It dumps cleanly and quietly into a large car upon the landing, the entire operation of emptying, receiving, and commenced descent occupying but a few seconds and requiring no outside aid whatever. The large car, when filled, is run out and dumped at the convenience of the engineer. The skip has safety catches attached. The design was necessary from the somewhat unusual pitch of the shaft—too steep for a car and not steep enough for the ordinary cage.

Two cords of wood are burned in twenty-four hours. The wood is cut on the company's property, and costs $2 25 per cord, delivered at the works. At the time of visit nine men were employed, two on top and seven underground. These entire operations have been performed during the last year.

MERRIMAC MINE.

The Merrimac Mine is 2 miles northeast of Grass Valley. The dimensions of the property are 1,300 by 600 feet. The course of the vein is east and west, dipping north at an angle of 42°. The average width is from 18 inches to 3 feet. Both walls are slate.

The mine is opened by an incline shaft upon the vein. A drain tunnel 400 feet in length, running upon the vein for 300 feet of its course, intersects the shaft 110 feet from the surface. The total depth of the shaft is 385 feet; there are two levels below the tunnel level. The second level, at a depth of 200 feet on the incline, extends east 350 feet, and west an uncertain distance, being caved. The third level, at a depth of 300 feet, extends east 150 feet and west 70 feet. The shaft is being sunk for another lift, and at date of visit was down 85 feet below the third level. There is one ore shoot 300 feet in length. The greatest length of ground stoped is 350 feet. The dimensions of the shaft are 12 feet by 5 feet; it is timbered the entire distance. Spruce poles are the timb

used in the mine. The water is kept down by an 8-inch pump running six strokes per minute; about 80,000 gallons of water are raised per day. The formation in the mine is easy working, the cost of labor in sinking the shaft being but $6 per foot.

The ore is banded quartz, carrying galena in addition to free gold. a noticeable fact, the usual accompanying mineral in the district being pyrites. There is a substantial hoisting and pumping plant upon the property, containing a 10-inch horizontal pumping engine and a 10-inch hoisting engine, together with the necessary hoisting and pumping machinery. Two cords of wood per day are consumed in furnishing power; this is cut on the company's ground, and costs $2 per cord. A total of eight men is employed—six men underground in sinking shaft, and two engineers on surface. Wages are $3 per day.

CENTENNIAL MINE.

This mine is situated near the summit of Osborn Hill, at an elevation of 3,000 feet, 2 miles southeast of Grass Valley. The dimensions of the property are 3,000 feet by 600 feet. A portion was first located and worked in 1851. The course of the vein is north and south, dipping west at an angle of about 30°; the average width is one foot. The formation is diabase in both walls. The mine is opened by an incline shaft 650 feet in depth; six levels are run from the shaft with a maximum extent south of 200 feet, and north of 600 feet. The shaft is close timbered for 120 feet, this work having been recently done; its dimensions are 5 feet by 9 feet in the clear, with two compartments, hoisting and pumping. The cost of sinking shaft in hard ground is $14 per foot. Thus far one shoot of ore 250 feet in length has been discovered; it has a rapid trend to the south.

There is a substantial structure on the mine, containing hoisting and pumping plants, and which is so designed and constructed that either a five or a ten-stamp mill can be erected therein. Preparations are being made to put in five stamps, and to proceed to the actual development of the mine. The ore is a well-ribboned, free-milling quartz, containing fine gold well disseminated through it, and a large percentage of sulphurets of very high grade, consisting principally of galena and pyrites.

On account of the location of the mine, almost upon the summit of the hill, the amount of water coming in is very light. A 6-inch pump with a 4-foot stroke, and a 4-inch pump in the bottom, handle all of the water. A twenty horse-power pumping engine and an 8-inch hoisting engine are sufficient to perform the necessary work.

HERMOSA MINE.

This mine is situated 1 mile south from the town of Grass Valley, at an altitude of 2,500 feet. The property has an extent upon the Hermosa vein of 2,400 feet. A parallel vein has dimensions of 800 by 600 feet. The course of the Hermosa vein is north and south, dipping west at an angle of 35°. The vein is a large one for this district, varying in width from 2 to 2½ feet; the formation is diabase in both walls.

The mine is opened by an incline shaft upon the vein 500 feet in depth. Three levels are run from the shaft, as follows: No. 1, at a depth of 100 feet, extending north 50 feet and south 40 feet; No. 3, at a depth of 300

feet, extending north 66 feet and south 136 feet; No. 5, at a depth of 500 feet, extending north 22 feet and south 20 feet. The drifts on the 300 and 500-foot levels were being rapidly driven at time of visit. The length of the ore shoot has not as yet been proved by the developments. The vein was worked on surface for a distance of 900 feet. The 300-foot level shows a length of over 200 feet, with the vein still in drift. The pumping system consists of two pumps, an 8-inch at the No. 3 level and a 6-inch at the bottom. About 20,000 gallons of water per day are pumped from the mine. Ventilation is provided by two air shafts sunk to the 100-foot level, one on each side of the shaft. The lower workings are furthermore provided with air pipes, through which air is forced from the surface by means of a water blast. All of the water from the mine is pumped into the tank; the overflow is converted into a water blast, and the mine thus thoroughly ventilated. The dimensions of the main shaft are 10 feet by 6 feet, the sinking of which costs for labor $10 per foot. The company cuts all the timber from its own property; lumber is obtained for $16 per thousand feet, delivered.

The ore is banded, free-milling quartz, containing pyrites and galena.

The plant consists of hoisting and pumping works, containing pumping and hoisting engines and boilers. A little over two cords of wood, costing $3 75 per cord, are used daily.

During the past year almost all work on the property has been done, the plant being erected, over 300 feet of shaft having been sunk, and the Nos. 3 and 5 levels opened up. The 500-foot level is now being opened up with good prospects, and the sinking of the shaft will be resumed as soon as the drifts are in far enough to admit thereof. The ore shoot has increased in value as depth was attained, both in characteristics and in grade. The outlook in the bottom of the mine is very promising, the ore shoot going down strong, and of good character, under the 500-foot level. At the time of visit a total of eighteen men was employed—three top men and fifteen underground.

ST. JOHN MINE.

This mine is situated on Alta Hill, one half mile north of the town of Grass Valley. The dimensions of the property are as follows: Length, 3,500 feet; width, 200 to 700 feet. The vein courses east and west, and dips south at an angle of 70°. The size of the vein is large for this district, averaging over 6 feet throughout, and increasing to 8 feet in the bottom. The vein is on the border of what is known as the serpentine belt. The hanging wall next to the vein is calcareous diabase, while a few feet farther in it changes to a strong belt of argillaceous talc, containing a very considerable percentage of pyrrhotite. The foot wall is talcose schist. The mine is opened by an incline shaft upon the vein. The dimensions are 4½ feet by 7 feet. The shaft has a total length of 250 feet.

There are two levels, the first, at a depth of 150 feet, and the second at the bottom, 250 feet. As far as developed one ore shoot has been found, extending from the shaft to the west a distance of 150 feet. The first level runs west 125 feet, and the second 150 feet, with the ledge still strong in the breasts of the drifts. An air shaft, 90 feet in depth, connects with a raise from the first level, and furnishes ventilation. The ore is well mineralized throughout, carrying a large percentage of

iron and copper pyrites and showing galena freely. The water in the mine is very light and is handled by a 6-inch pump on a short stroke, running at lowest speed. Hercules No. 2 powder is the explosive used. At present, seven men are employed, with wages at $3 per day. The mine is equipped with steam power throughout, a 10-inch engine supplying the necessary power for pumping and hoisting. About 250 tons of ore have been accumulated on the dump from the development work. It is proposed to erect a mill.

Almost all the above described work has been done during the year 1891, and in addition thereto a total of 400 feet of crosscut has been run. About one cord of wood is consumed per day.

TELEGRAPH MINE.

This mine is situated on Ophir Hill, on the eastern border of the townsite of Grass Valley. It was located in 1879. Its dimensions are 1,100 by 600 feet.

The Telegraph claim adjoins the W. Y. O. D. Mine on the north, and is presumably located upon the extension of this vein. The course of this vein is north and south, dipping west at an angle of 35°. The vein in the shaft at present shows a size of 1 foot. The formation is syenite in both walls.

The mine is being opened by an incline shaft upon the vein, having at date a depth of 175 feet. A level will be turned and driven both north and south as soon as a depth of 225 feet is attained. The dimensions of the shaft are 8 feet by 5 feet in the clear. A vertical air shaft furnishes ventilation at present. Hardly any water has been found at this depth, a few barrels per shift being hoisted.

The mine is equipped with a steam hoisting and pumping plant, consisting of an 8-inch engine and a 36-inch boiler; only one half cord of wood is burned per twenty-four hours. Nine men are worked at present.

HUDSON BAY MINE.

The Hudson Bay Mine is situated 1½ miles south of Grass Valley, adjoining the New Rocky Bar Mine. The claim has an extent upon the lode of 1,600 feet. The course of the vein is north and south, dipping at an angle of about 30°. The average width of the vein is 1 foot; it is inclosed in diabase in both walls. The mine is being prospected by a vertical shaft. This shaft is so situated that it will intersect the vein at a point on the inclination about 250 feet from the croppings. The shaft has dimensions of 8 feet by 4 feet in the clear. It is costing at present $25 per foot, including both labor and supplies. The shaft has a depth of 115 feet, and it is expected to intersect the ledge in 15 feet more.

The quantity of water making in the shaft is small—less than one miner's inch. A 6-inch pump on a short stroke handles the water very readily. The plant is a Hendy prospecting rig, inclosed in a substantial hoisting works. The plant is run by steam, a trifle over one half cord of wood being consumed per day.

Eight men are employed at present—two on top, and six underground.

HARTERY MINING COMPANY.

The Winfield Scott Mine, now owned and operated by the Hartery Mining Company, is situated on the west bank of Wolf Creek, one half mile north of the Allison Ranch Mine, and 3 miles south of Grass Valley. The claim is 1,500 feet in length, its width varying from 400 to 600 feet. The width of the vein is 1 foot. It lies in a syenite in both walls.

The mine is opened by an incline shaft 5 feet by 10 feet in the clear, and 400 feet in depth. The first level is turned at a depth of 300 feet, and extends north 200 feet and south 50 feet; the second level is being turned at the bottom. The water is not heavy, and is handled by a 6-inch pump. Shaft sinking costs $12 per foot for labor.

The ore is a crystalline quartz, containing a small percentage of mineral, mostly pyrite, besides free gold. There is an excellent hoisting and pumping plant on the property, containing a 10-inch pumping engine, boiler, and all necessary hoisting and pumping machinery. A little over one cord of wood is burned per day.

Twelve men are employed at present, three on surface and nine underground. Miners' wages, $3 per day.

LAFAYETTE MINE.

The Lafayette Mine is situated 2 miles southeast of Grass Valley, near the summit of Osborn Hill. The altitude is 2,950 feet. The dimensions of the claim are 1,500 by 600 feet. The course of the vein is north and south, dipping west at an angle of 25°; the average width is 1 foot. The vein lies in diabase in both walls. The fissure is well defined, the ledge lying upon the foot wall, with a comparatively easy-working slate casing between it and the hanging wall.

The mine is opened by a tunnel, crosscut for 480 feet, then running north 80 feet and south 500 feet on the course of the vein. This tunnel is timbered for a few feet only, being in firm standing ground; it cost about $4,000 to drive. The cost of driving is now $3 50 per foot for labor. A vertical depth of 80 feet has been attained, giving in the neighborhood of 200 feet of "backs" upon the ledge. The ore shoot is about 500 feet long as far as run on; the greatest length of ground stoped to date is 150 feet.

Ventilation is afforded by an air shaft 80 feet deep. The ore is well-ribboned quartz, carrying pyrite and galena in addition to free gold.

Five men are at work at present, having taken the mine on lease. The last three crushings of ore have returned from $20 to $50 per ton.

MARYLAND MINE.

This mine is situated 1½ miles west of Grass Valley, adjoining the noted Idaho Mine on its eastern boundary. The dimensions of the property are 2,000 by 600 feet. The property is located on the extension of the Idaho lode. The course of the vein is east and west, dipping south at an angle of 75°. The depth of the shaft is now 330 feet. A drain tunnel intersects the shaft at a depth of 130 feet, and relieves the mine of its surface water. The dimensions of the shaft are 9 feet by 4½ feet in the clear. The hoisting and pumping plant is operated by water

power taken from the Idaho pipe-line, and having a head of nearly 500 feet; thus affording one horse-power to the inch of water. A 6-inch pump suffices to keep down the water.

SEVEN-THIRTY MINE.

This mine is situated on Dead Man's Flat, 4 miles southeast of the town of Grass Valley. The dimensions of the property are 3,000 by 600 feet. The course of the vein is north and south; its dip west, at an angle of 65°. The average width of the vein is 8 inches.

The mine is opened by an incline shaft 170 feet deep. Ventilation is procured by means of an air shaft farther to the south, and 100 feet in depth. Two levels are run from the shaft. The ore shoot appears to be continuous, and has been worked for several hundred feet on the surface. The water is very light, and is handled by a 4-inch pump, running fourteen 4-foot strokes per minute. The dimensions of the main shaft are 8 feet by 5 feet, and it is timbered throughout, costing $20 per foot to sink.

The formation is the same as in the California Mine, which lies a little to the north; it consists of a calcareous diabase in the hanging wall, while the foot wall is a very hard diorite.

The ore is handled and crushed at present in the California mill; it is a white crystalline quartz, containing very little mineral, but having rich free gold "shoots" of specimen ore. Outside of these rich shoots the grade of the ore is low.

Steam power is used, an 8-inch engine doing the entire work. One half cord of wood is burned per day. At the time of visit five men were employed in the mine.

NEW ROCKY BAR MINE.

This mine is on New York Hill, 2 miles south of Grass Valley. The dimensions of the property are 37 acres, having an extent of about 2,000 feet upon the lode. There are five distinct and nearly parallel veins on the property, two dipping to the north, on one of which the main workings have been situated, and the others dipping south. The present operations are carried on upon one of the south dipping veins, which lies very flat, and near the southern boundary of the property. The course of this vein is nearly east and west, dipping south at a very slight angle; the width is from 8 to 10 inches. The vein lies in diabase in both walls. This portion of the mine is opened by vertical shafts, the ground being drained by the underlying North Star workings, and the ore and waste hoisted with whims. There are three vertical shafts, with a depth of from 100 to 110 feet; this flat ledge is followed and worked from the bottoms of these shafts. The ore is free-milling, ribboned quartz, containing coarse gold, and usually of high grade; it is handled and crushed in custom mills. Eighteen men are employed, working the mine on tribute, paying royalty to the owner.

WISCONSIN MINE

This mine was fully described in the last report. The property has an extent upon the lode of 3,400 feet, the vein coursing northwest and southeast, and dipping southwest at an angle of 35°. The vein lies in

syenite in both walls. During the last year the shaft has been sunk 115 feet, now having a total depth of 285 feet on the incline. A level was turned at a depth of 240 feet and the south drift driven 110 feet. The 135-foot level was also extended over 100 feet north and nearly that distance south. At present ten men are employed in the mine.

GREEN MOUNTAIN MINE.

This mine is situated 2 miles southeast of Grass Valley, on Osborn Hill. The dimensions of the claim are 2,800 feet in length by 300 to 400 feet in width. There are three parallel veins in the property, the Green Mountain vein lying farthest to the east, and the Sanders and Payday veins following to the west; the course of these veins is north and south, dipping to the west. The present operations are being conducted upon the Payday vein, which dips at an angle of 60° from the horizontal. The veins lie in diabase throughout.

The mine is opened by an incline shaft 185 feet in depth. The dimensions of the shaft are 9 feet by 5 feet. Two levels are run from the shaft, the first at a depth of 90, and the second at a depth of 180 feet. The 90-foot level runs north a few feet and south 100 feet; the lower level runs south from the shaft 150 feet. A 6-inch pump handles the water. The plant on the property consists of a hoisting works, containing a 10-inch horizontal engine for pumping and hoisting. Six men are employed.

NEVADA CITY MINING DISTRICT.

The Nevada City Mining District is second only to the Grass Valley District in the magnitude of operations and the successful results attained. Quartz mining was inaugurated here shortly after it was begun in Grass Valley, and although the earliest operations were not very successful, owing to inefficient machinery and a lack of knowledge of past workings, work has since been pursued with good success, and the present outlook is most flattering. During the past two years successful operations have been started on various mines of the district, with no failure as yet reported.

The veins of the Nevada City District are larger than those of Grass Valley, varying from 2 to 6 feet in size on the average, and much larger in many instances. The ores are all more highly mineralized, the mineralization at times being very heavy.

Heavily mineralized shoots are met with, containing 40, 60, and 70 per cent of mineral. The gold in these veins is usually disseminated through the mineral, and, while free, it is only rarely that coarse or specimen gold is found. The average percentage of sulphurets in the veins will probably be in the neighborhood of 6 to 8 per cent. As a result of the heavy mineralization of the ores, there is a slight tendency to loss in the mill from sliming, and care must be taken in the mixing of the ores. The sulphurets consist largely of pyrites, with chalcopyrite, galena, and blende in considerable quantities. The sulphurets, as a rule, are of much higher grade than those in the Grass Valley District, running from $100 to $300 per ton; as a result a large per cent of the valuable contents is recovered from the sale of concentrates, which are either treated at local chlorination works or shipped to Melrose.

The geology of the Nevada City District is quite varied. Commencing at the southern portion, at Town Talk, where it joins the Grass Valley District, the formation is diabase. Going north this gives way to a metamorphic slate, which fringes the syenitic granite formation upon which Nevada City stands. The strong belt of granite comes in from the northwest, strikes down Wood's Ravine, west of this town, crosses Deer Creek, and passes south of the town through Gold Flat. Extending farther east, it strikes Banner Mountain, and turning north crosses Willow Valley, at a point a little west of the Federal Iron Mine, in its northward course.

The largest and most permanent veins in the district appear to be on the contact between this granite formation and the slate which borders it. The Nevada City, Wyoming, and Champion Mines are situated on this contact.

The Providence property contains two veins, one in the granite and one on the contact. The Spanish and Mountaineer Mines lie in the granite, while the Federal Loan lies in slate near the contact, and the Pittsburg in diabase near the contact. Other veins in the granite have not proved so reliable as those cited.

The Nevada City quartz veins are of large size, good grade, and heavily mineralized with free-milling ores. The mines are admirably situated for operations by water power, and the outlook is very prosperous.

The drift gravel mines of this district come under a separate head, and are mentioned elsewhere.

CHAMPION MINE.

This mine is situated on Deer Creek, 1 mile west from the town of Nevada City, at an altitude of 2,300 feet.

The property of the company, which was fully described in the last report, consists of a consolidation of ten claims, as follows: Merrifield, Climax, New Years, New Years Extension, Müller, Phillips, Ural Relocation, Bavaria, Merrifield Extension, and Mary Ann. Two parallel veins are included in the property, the more eastern being the Merrifield, and the western, or foot wall vein, the New Years.

The New Years vein courses north and south, and dips to the east at an angle of 42°. The mine is opened on this vein by a tunnel from Deer Creek, running in on the vein over 3,000 feet, and by an incline shaft on the vein, having a total depth of 1,000 feet. The tunnel attains a depth from surface of 600 feet. Ten levels have been driven from the incline shaft, at a distance of 100 feet apart. These levels run north from the shaft a distance of 1,000 feet.

Four ore shoots have thus far been discovered on the New Years vein: three north of the shaft and one south. These shoots all trend a little to the north; they vary in length from 135 to 150 feet. The ledge is of large size, running from 2 to 12 feet, with an average of 7 feet; the inclosing formation is slate. The water is not very heavy, the largest pump being an 8-inch plunger.

Spruce and pine timbers are used, the pine costing 3¼ cents per running foot of poles. Hercules powder is used. The cost of mining is very low, and does not exceed $2 per ton for extraction.

The ore from the vein is at times most heavily mineralized, some por-

tions containing as high as 50 to 80 per cent of mineral constituents. These are pyrite principally, with considerable quantities of galena, chalcopyrite, and blende; the ore also shows considerable quantities of free gold.

The Merrifield vein is in size somewhat larger than the New Years, running from 2 to 24 feet and averaging 9 to 10 feet. The inclosing formation is a syenitic granite in both walls. The ore is not quite so heavily mineralized as that from the New Years vein. Preparations are being made to again work this vein (which was recently purchased by the Champion Company) on a large scale. At present the drain tunnel is being cleaned out, and other preliminary work under way.

The ore from the Champion Mine contains about 6 per cent of sulphurets, running from $80 to $150 per ton, of which amount about 10 to 15 ounces is silver. This product is treated in the chlorination works owned by the company and situated in close proximity to the hoisting works.

During the past year the shaft was sunk 100 feet, and a large amount of ground opened by extending the various levels to the north. A crosscut has also been run from the New Years to the Merrifield vein. The entire plant is operated by water power, which is procured with a head of 218 feet, a total of 75 inches per day being used. Pelton wheels are used throughout, three being required.

The ore is crushed in a fifteen-stamp mill, crushing 2 tons to the stamp per day. The stamps weigh 750 pounds, and are dropped 7 inches ninety times per minute.

The mill has been greatly improved during the last year, a rock-crusher and self-feeders having been put in during this time. Steel shoes and iron dies are used. The sulphurets are saved on Frue concentrators, and are treated in the chlorination works of the company. Only three men are employed in the mill.

The chlorination works are admirably conducted and do excellent work on the Champion ore, which requires careful treatment, on account of the percentage of lead contained, and likewise the proportion of silver in the concentrates. It contains one long, one-step reverberatory furnace, 65 feet by 10, inside measurement; the capacity is 4 tons per day. Six to eight hours are required for the charge to go through.

There are four vats for chlorination and four for leaching for silver, the capacity of each being 2½ to 3 tons. On a lower floor are four vats for the precipitation of gold and a like number for the precipitation of silver. By a very clever and ingenious process, devised by Mr. Maltmann, who has charge of this plant, a remarkably high percentage of the silver contained is extracted.

Five men are employed in the chlorination works. Fifty-six men and boys are employed underground, three in the mill, and five in the chlorination works. Miners' wages underground are $3 per day.

MOUNTAINEER MINE.

The Mountaineer Mine is situated 1 mile west from the town of Nevada City, on the north bank of Deer Creek. The claim has an extent of 3,000 feet on the lode line, the vein coursing northwest and southeast, and dipping to the northeast at an angle of 38°. It is parallel to and

adjoins the Champion and Providence Mines, forming one of a group of dividend-paying properties.

The mine is opened by a tunnel 1,700 feet in length, with an incline shaft sunk from it in the vein at a point 1,000 feet from the mouth. A vertical depth of several hundred feet is attained by the tunnel. The shaft is sunk a distance of 750 feet, the inclination thereof being 38°. At the head of the shaft a large chamber (65 by 22 feet) is cut out to contain the necessary hoisting and pumping machinery, and forms a landing station. At a point in the tunnel 950 feet from the mouth, there is an upraise, 400 feet in length, to the surface; this furnishes an air shaft and second means of egress from the mine. There are six levels turned from the shaft, extending north a maximum distance of 1,100 feet, and south a distance of 650 feet. There are two shoots of ore worked, each having a pitch to the northwest of from 7° to 10°.

The ore from the mine is of good grade, free milling, and at times heavily mineralized, containing as high as 60 to 80 per cent of metallic contents. This heavily mineralized ore is usually of very high grade, running from $200 to $300 per ton; the mine has been a steady and profitable producer for years.

The ore is reduced in a twenty-stamp mill, of which fifteen stamps were running at time of visit. The stamps weigh 700 pounds, dropping 6 inches sixty-five times per minute, and crushing, through No. 4 diagonal slot screens, 1½ tons each per day. The ore yields an average of between 3 and 4 per cent of sulphurets, which are saved on six Frue vanners; the product is high grade, running from $100 to $180 per ton. The product is sold to the highest bidder, and treated in local chlorination works, or shipped to smelters.

The entire plant is run by water power, 50 inches under a head of 200 feet being required. The cost is 18 cents per inch. A 5-foot Pelton wheel is used for hoisting, and one of the same dimensions for pumping; a 5-foot Knight wheel furnishes power for the mill. A 10-inch pump in the shaft keeps the mine free of water; about 15 miner's inches of water is pumped from the mine.

During the past year the shaft has been sunk 150 feet, and a large amount of drifting done. Fifty men are employed in the mine, and six men in the mill and on surface work. Miners' wages are $3 per day.

NEVADA CITY MINE.

The Nevada City Mine, owned and operated by the Gold Hill Mining Company, is situated about 1½ miles west of Nevada City, in Wood's Ravine.

The property comprises a consolidation of two claims, one originally located in 1850, and the other in 1869. The dimensions of the combined claims are 2,500 feet in length by 600 feet in width. There is one main vein in the property corresponding to the Wyoming vein in the adjoining property of that name to the south. The vein makes a decided turn at a point near the center of the property, changing from a north and south course, which it maintains in the southern portion of the ground, and swinging suddenly farther to the west, making its course more nearly northwest and southeast. The size varies from 1 foot to 12 feet, with an average size throughout of about 3 feet. The vein follows the contact between the two formations throughout, the hanging wall

being syenitic granite, the foot wall a partially metamorphosed slate. The formation is large, requires careful timbering, and makes considerable water.

The mine is opened by both tunnel and shaft; the tunnel, which serves only as a drain tunnel, is over 5,000 feet in length, and commences in the Wyoming property, running through the Wyoming Mine, and into and through the Nevada City property. At the point where it enters the Nevada City ground it gives a depth on the vein of 350 feet, measured on the inclination, and at the northern end of the ground this distance increases to 600 feet. The tunnel follows the vein the entire distance, and is timbered throughout.

As far as worked five main ore shoots have been developed and stoped. The length of these shoots varies from 200 to 400 feet, the greatest length of ground stoped on any level being 1,200 feet. Stoping has been done on every level, the ore shoots going down very regularly, and trending slightly to the north.

There are two main shafts on the property, situated about 1,200 feet apart. The first, or "old" shaft, is situated on the southern portion of the property on that part of the ledge having the north and south course. It has a length of 1,000 feet, with an inclination of 32°, and was equipped and used for both pumping and hoisting. The second, or "new" shaft, is situated to the north, on the portion of the vein having the northwest course, and is equipped for hoisting only, being sunk 500 feet on the incline and not as yet below the drain tunnel, which it intersects at this point, the latter forming the 500-foot level of this portion of the mine. Seven levels have been run from the old shaft, extending 200 to 300 feet south and 1,100 feet north. Four levels have been run from the new shafts. All operations are at present carried on at or above the drain tunnel level, and it has not as yet been necessary to pump out the old workings and commence new developments below this level.

The cost of mining is low, about $2 50 per ton for extracting alone. Giant No. 2 is the explosive used. Spruce timber is used in this district. Lumber costs $16 per thousand feet, delivered. The dimensions of the two shafts are 5 by 7 feet in the clear.

The ore is reduced in a ten-stamp mill, situated at the "old" shaft, and for the present is hauled from the "new" shaft. The ore is a banded quartz of good quality, carrying free gold plainly visible, and containing about 2 per cent of very high-grade sulphurets. These consist for the most part of pyrite, with some galena, blende, and chalcopyrite; the average grade is $200 per ton. The stamps weigh 750 pounds, drop 6 inches one hundred times per minute, and have a capacity of $1\frac{6}{10}$ tons per stamp per day. The height of discharge is 5 inches, and No. 7 slot-punched screens are used. Cast-iron shoes and dies are used. The apron plates are 4 feet by 5 feet in size. The concentrates are saved upon four Frue concentrators.

The entire plant is run by water power, under a head of 300 feet; 45 inches per day is used, at a cost of 18 cents per inch. Pelton wheels are used, a 10-foot wheel in mill and a 4-foot for hoisting.

The development in the last year was all made from the upper shaft, and consists of the following: The 100-foot level north and south entire; 300 feet in the 300-foot level north; 400 feet in the 400-foot level north, and the entire 500-foot level north, 480 feet in length; a total of 1,750 feet of drifting.

At present twenty-four men are employed in the mine, and four in the mill. Miners' wages, $3 per day.

FEDERAL LOAN MINE.

The Federal Loan Mine is located on the south bank of Deer Creek, in Willow Valley, about 3 miles northeast of Nevada City. The property consists of one full-sized claim of 1,500 feet by 600 feet.

The mine is opened by an incline shaft on the vein, sunk to a depth of 400 feet. The third and present bottom level is turned at a depth of 400 feet, and has a total extent east and west of 140 feet. The vein varies in width from 1 to 4 feet; it is heavily mineralized, containing in addition to free gold, pyrite, chalcopyrite, galena, and blende, the average yield of concentrates exceeding 6 per cent. A noticeable characteristic of this vein is the large amount of mineral found in the inclosing slate; in almost every instance it is found that the grade of this inclosing formation is high enough to admit of a profit from the milling thereof.

There are two shoots of ore, one on each side of the shaft. The eastern shoot cropped out on the surface, and has been followed down, while the west shoot did not appear until the second level was driven, at a depth of 300 feet upon the incline.

The timber used in the mine is spruce entirely, and is obtained in the immediate vicinity. There is considerable water coming in; a 10-inch plunger on 3-foot stroke handles it, the column emptying into the drain tunnel 40 feet below the surface, the drain tunnel carrying off the bulk of the surface water; 170,000 gallons of water per day is pumped from the mine. The total cost of mining and milling is between $6 and $7 per ton.

The company has built about one half mile of road. The ore is treated in a five-stamp mill, situated about 100 feet from the hoisting works, so that ore can be trammed easily into the ore bins. The mill building is all completed for ten stamps, which will be added at once. The five stamps now running weigh 750 pounds each, drop 6 inches, are run at a speed of ninety-five to one hundred drops per minute, and crush 7½ tons per day. The screens are round-punched No. 1 wire, in inclined frames. The run of plates is 4 feet wide and 12 feet long; about one third of the amalgam is saved in the battery. The concentrates are saved on Frue concentrators, and average $100 per ton.

Seventeen men are employed at the mine, and three men in the mill.

The entire plant is run by water power, the property being most favorably situated in this regard.

Two hundred feet fall is obtained from a pipe-line less than 800 feet long, with a result that 14 inches per day is sufficient to produce the power for the entire plant.

The average grade of ore extracted to date is a little over $15 per ton, a total of 1,350 tons having been crushed since the erection of the five-stamp mill. Wages paid in mine and mill, $3 per day.

PROVIDENCE MINE.

The Providence Mine is situated on the south bank of Deer Creek, 1 mile west of Nevada City, at an altitude of 2,340 feet. After an interval of about one year, work upon this mine has recently been inau-

gurated. The shaft has been retimbered from top to bottom, and the entire system of pumps put in, consisting of two 10-inch and one 8-inch plunger pumps, and a 6-inch lift pump in the bottom. New pump-rod and column have been put in throughout.

The property contains 154 acres, with two veins that have been worked. One vein is on the contact between the syenitic granite and slate formations, and the other lies entirely in the granite, 600 feet to the east, and in the hanging wall. The two veins dip east at an angle of 36° to 40°. The main shaft is upon the eastern or Providence vein, and the greater part of the work in the past was prosecuted on this vein. The incline shaft is 1,250 feet in depth, ten levels being turned, and extending an average distance of 2,000 feet on the vein. The Providence vein is a larger one, running from 2 to 20 feet in size, and averaging over 6 feet. Four shoots of ore have been discovered on it, running from 150 to 320 feet in length. These ore shoots all trend to the north. The work at present prosecuted on this vein consists of driving and opening ground on the 1100-foot and 1250-foot levels, and sinking the main shaft.

The western, or contact vein, was worked by means of a crosscut from the Providence vein on the 600-foot level; this crosscut was about 600 feet in length. The ore shoot on this vein was over 300 feet in length, and was stoped out from the 600-foot level to the surface. This ore was of high grade, the vein averaging 5 feet, and being heavily mineralized.

A crosscut is now being driven from the 1250-foot level of the Providence vein, which will give, when the vein is intersected, 650 feet of "backs" on the contact vein.

A Burleigh compressor has been put in, and a National drill is used in this work. Safety Nitro No. 2 powder is the explosive used.

There is a forty-stamp mill on the mine, twenty stamps of which have been overhauled and are in running order. The entire plant is operated with water power under a fall of 380 feet at the mill and 320 feet at the hoisting works. The plant is also provided with steam engines, to be used in case the water supply should at any time be temporarily shut off.

A Dodd wheel is employed to run the compressor, and gives satisfaction. Twenty-five men are employed; miners' wages, $3 per day.

WYOMING MINE.

The Wyoming Mine is situated 1½ miles west of Nevada City, in Wood's Ravine, at its junction with Deer Creek. The dimensions of the property are: Length, 3,200 feet; width, varying from 200 to 800 feet. There are two veins on the property, parallel, and uniting in depth; the easterly, or hanging wall vein, is the Ural, and the westerly, the Wyoming vein. These veins both course northwest and southeast, and dip toward the northeast.

The Ural vein dips northeast at an angle of 30°; it varies in width from 4 to 8 feet, and averages between 5 and 6 feet. The Ural vein is on the contact, having the granite in the hanging and metamorphic slate in the foot wall. This vein is opened both by tunnel and shaft; the tunnel starts on the bank of Deer Creek and extends 3,000 feet in the property, running on to the north in the Nevada City Mine. The tunnel is timbered its entire distance, and serves as drain tunnel for this and the

neighboring mine; its dimensions are 6 feet by 4½ feet. An incline shaft sunk on this vein has a total depth of 800 feet, and intersects the tunnel at a depth of 400 feet upon the incline. The dimensions of this shaft are 8 feet by 5 feet in the clear.

Four levels are turned from the Ural shaft, extending south 300 feet and north 400 feet. Several shoots of ore were encountered, varying in length from 74 to 200 feet; all these shoots on the Ural ledge have a distinct trend to the north.

The Wyoming vein varies in size from a few inches to 20 feet; its average width is between 2 and 3 feet. The vein lies in the foot wall, and consequently has a slate formation in both walls. It is opened by three incline shafts, on two of which there are hoisting and pumping plants at present. Of these two principal inclines, the northern one, 1,100 feet from the Nevada City Mine boundary, is down 900 feet. The south shaft, situated near the machinery at the bank of Deer Creek, is down 375 feet. The north shaft is connected with the drain tunnel on the Ural vein, while the south shaft has its own drain tunnel, deeper than that on the Ural vein, and meeting the shaft at a depth of 140 feet on the incline. Both incline shafts have the same size, their dimensions being 8 by 5 feet in the clear. There are nine levels from the north shaft, running north 900 to 1,100 feet; the drain tunnel is the only south level. From the south incline there are two levels; the first, at a depth of 140 feet, runs north 150 feet; the second, at a depth of 340 feet, runs north 400 feet and south 200 feet. The workings through this shaft constitute the present mine, no work being carried on at present except at this point. The water is raised by a 6-inch pump. Hercules No. 2 powder is the explosive used. The plant on the north incline was run by steam; the machinery at the south shaft is operated by water power.

The power water is delivered under a head of 328 feet, 15 inches being used, costing 18 cents an inch. The cost of sinking the shaft is $7 per foot for labor. The ground all requires timbering.

The shoots of ore on the Wyoming vein are very irregular, and cannot be said to have any distinct trend. Three distinct ore shoots have been found, one north of the north incline, and having a length of 1,200 feet, and one on each side of the south incline. Work at this point has not progressed enough to determine the length of ground stoped on any level. The greatest length of ground stoped on any level is in the neighborhood of 1,300 feet.

At present seven men are employed in the mine, two on top and five underground. A larger force will be put on as soon as the workings will admit, which will be very soon. It is the intention of the management to block out a suitable body of ore, when a new mill will be erected at this shaft. Miners' wages, $3 per day.

SPANISH MINE.

This mine is situated near Wood's Ravine, 1¼ miles northwest of the town of Nevada City. The property consists of one claim, 1,500 by 600 feet, and was located prior to 1860. The course of the vein is northwest and southeast, dipping to the northeast at an angle of 42°. The vein is parallel to the Nevada City vein, lying about 1,000 feet to the south, and as the property adjoins the North Merrifield claim, the Spanish vein is considered to be the extension of the Merrifield vein. It lies in the

same formation, being a syenitic granite in both walls. The vein is a large one, averaging 3 feet in size, and as the casing is quite soft, the cost of extraction is low. It contains pyrite as the principal mineral constituent, showing also copper pyrites and galena at times.

A drain tunnel 600 feet in length and cutting the vein 120 feet from surface, relieves the mine of its surface water; it is timbered its entire length. There are two known shoots of ore, one to the east of the shaft, 120 feet in length, and one to the north, 150 feet in length, the two shoots being 300 feet apart. It is not yet evident whether these ore shoots have a trend in either direction. The mine is worked through an incline shaft 220 feet and having an inclination of 42°.

The dimensions above the drain tunnel are 5 feet by 5 feet in the clear, and below the tunnel 7 feet by 5 feet. There is one level at a depth of 270 feet below the surface; it extends east a distance of 225 feet.

There is very little water in the mine; an ejector is employed to keep it clear. Three inches of water only is required for this work; 2 inches is sufficient for hoisting, making a total of 5 inches used outside of the mill.

The cost of mining is low, not exceeding $2 per ton; cost of labor for sinking is $5 to $6 per foot.

The ore is reduced in a five-stamp mill, with 850-pound stamps, dropping 7 inches one hundred times per minute. The duty per stamp is 2⅔ tons per day. Steel wire screens, twenty-four mesh, are used, and prove more satisfactory than brass wire. The plate run is of ample size, composed of 4x5-foot apron, and sluice run 4 feet wide and 10 feet long. A 2½-inch inside battery plate is used; all plates are silvered. The concentrates are saved on two Frue concentrators; the value of this product is from $75 to $175 per ton. Power is furnished by a Pelton wheel, the power water having a head of 190 feet at the mill; 15 inches is required to run the mill.

The total number of men employed in mine and mill at time of visit was five; wages paid, $3 per day.

GOLD FLAT MINE.

The Gold Flat Mine is situated in Gold Flat, 1 mile south of the town of Nevada City. The property comprises three claims, as follows: The Gold Flat, 1,500 feet by 600 feet; Potosi, 1,500 feet by 600 feet, and the Mohican, 3,000 feet by 600 feet.

The Gold Flat and Potosi claims are on the same vein, which courses north and south, while the Mohican is a cross vein, with an east and west course. The Gold Flat vein dips east at an angle of 36° to 40°, and has an average width of 18 inches. The Mohican vein dips south, with a width of 1 foot. The plant is situated on the Gold Flat claim, and all work at present is being prosecuted on the Gold Flat vein. The formation throughout the entire property is a diabase in both walls.

The mine is opened by an incline shaft 300 feet in depth, on an inclination of 40°; its dimensions are 5 feet by 10 feet in the clear. Two levels are turned from the shaft, the first, at a depth of 220 feet, extending north 150 feet; the second, at a depth of 300 feet, extends south 90 feet. There are two shoots of ore, as far as known; the first, in the Gold Flat claim, is 80 feet in length; the second, in the Potosi claim, is 150 feet in

length. The lower level is now in the Gold Flat shoot, while the upper level is being driven to cut the Potosi.

A 10-inch plunger pump is used to keep the mine free of water, and 115,000 gallons are pumped per twenty-four hours. The ground in the mine is not hard, drifting costing from $3 to $4 per foot. The ore is a well-mineralized quartz, containing pyrite in addition to free gold.

There is a substantial plant on the property, containing hoisting and pumping machinery, the latter being of a heavy order and well put in. The entire plant is run by water power, delivered by a pipe-line 1,950 feet in length with a fall of 300 feet. Water costs 18 cents per miner's inch, and 28 miner's inches is used. Two Pelton wheels are used for generating power—a 4-foot for hoisting and a 5-foot for pumping. These improvements have been erected and the mine pumped out during the year.

Ten men were employed at time of visit, two on top and eight underground. Miners' wages, $3 per day.

ORIGINAL PITTSBURG MINE.

This mine is situated 1½ miles east of Nevada City. The dimensions of the property are 3,000 feet by 600 feet. The course of the vein is north and south, dipping east at an angle of 45°. The formation is diabase in both walls.

The mine is opened by an incline shaft, with a drain tunnel to carry off surface water. The drain tunnel is 900 feet in length, and meets the shaft at a distance of 180 feet from the collar. The shaft is 1,000 feet in depth, and ten levels are run from it. Its dimensions are 14 feet by 5 feet in the clear.

At present operations are being prosecuted in virgin ground to the south of the shaft, and with excellent results as far as gone. A new shoot of high-grade ore has been discovered and opened up in the 300-foot level south, 400 feet south of the shaft. In the drain tunnel, also to the south, a shoot has been found and ore is being extracted. The 400-foot level, north and south, is being cleaned out, with the intention of cutting, when sufficiently advanced, the ore shoot exposed in the 300-foot level. The vein in these south workings varies from 1 to 2 feet in size, and the ore is of excellent grade, yielding from $20 to $100 per ton in free gold. The length of these south shoots is at present unknown. Pumping is not being carried on at present below the 500-foot level; an 8-inch pump at this point, running six hours per day, keeps the mine free of water.

The plant on the property consists of hoisting and pumping works, and an excellent ten-stamp mill, situated close thereto. The entire plant is run by water power, there being an auxiliary steam hoisting and pumping plant, for use in case of failure of water supply from any cause. The water is delivered at the works with a head of 185 feet, and costs 14 cents per inch. Pelton wheels are used throughout.

The ore is a heavily mineralized, ribboned quartz, containing, in addition to free gold, a varying but very considerable percentage of pyrite, with galena. The resultant sulphurets are frequently of very high grade, running from $50 to $350 per ton. The ore is treated in the stamp mill, the stamps weighing 1,000 pounds, and dropping 8 inches ninety times per minute. The ore is crushed through forty-mesh brass

wire screens, the gold being saved on an excellent run of plates 24 feet long and 5 feet wide. The concentrates are saved on four Frue concentrators. Milling costs but 65 cents per ton, one man only being required in the mill on each shift, through its admirable construction and arrangement.

The old dump and underground stulls were also being worked at a profit, twelve men being employed on this work. Twelve men were also employed in the mine, a total of twenty-four throughout. Miners' wages, $3 per day.

MAYFLOWER MINE.

The Mayflower Mine is situated on Canada Hill, 2 miles east of Nevada City. The shape of the property is very irregular, and it contains about 150 acres.

There are five veins on the property that have been worked; all nearly parallel, but varying greatly in dip. The Mayflower vein lies farther to the north, and dips south at an angle of 26°. In front of it is a flat vein with but very little dip, running to the western boundary; then nearly vertical veins fall into the "flat ledge" at various points. The Mayflower and the flat vein are the principal ones, and on them almost all the work has been done; a little ore has been extracted from the vertical veins, but for the most part these are of very low grade.

The Mayflower vein has been worked out above the old tunnel, and a new one is now being run, which will cut the vein at a depth of 300 feet on the incline, and will give 180 feet of "backs." This tunnel was a crosscut for 500 feet, and after intersecting the vein has been driven 400 feet thereon. In 100 feet farther the ore shoot will be met; this ore shoot is of good grade, and was 500 feet in length in the upper tunnel, varying in size from 8 inches to 4 feet. The tunnel is timbered throughout, and costs from $3 to $3 50 per foot.

The flat vein is opened by five crosscut tunnels run in from the ravine, and cutting the vein at a distance of 400 to 500 feet, giving about 120 feet of backs. From the end of the main or eastern tunnel a shaft has been sunk and is now down 100 feet, with drifts both ways, the east extending 8 feet and the west 100 feet. The dimensions of this shaft are 6 feet by 5 feet, and it and the tunnel are timbered their entire length.

The ore shoot on the flat vein is between 900 and 1,000 feet in length. A hoisting and pumping station was cut out at the head of the shaft. The water is very light, and is handled by a 4-inch lift pump. Judson No. 2 powder is the explosive used.

The ore is reduced in a four-stamp mill near at hand. The stamps weigh 950 pounds, drop 7 inches eighty-five times per minute, and have a capacity of 2 tons per stamp in twenty-four hours. The concentrates are saved on two concentrating tables—one Triumph and one Frue. The ore is a well-banded quartz and heavily mineralized, the notable characteristics being the large proportion of galena and blende contained, these minerals far exceeding the pyrite.

The entire plant is operated by water power, a small Pelton wheel at the shaft sufficing for hoisting and pumping, while an 8-foot wheel runs the mill. The power is delivered at the mill under a head of 155 feet, and at the shaft under a head of 170 feet. The mine has its own water right, and power is free. Seven men were employed underground at the time the mine was visited.

NORTH BANNER MINE.

This mine is situated on Little Deer Creek, at the foot of Banner Mountain, 2½ miles east of Nevada City, at an elevation of 3,200 feet. It was fully described in the last report.

Since last visited the incline shaft has been sunk 180 feet, now having a depth of 500 feet on the incline. The 300-foot south drift has been extended 200 feet, the 400-foot level turned and the drift driven north 180 feet, and the 500-foot level driven from the shaft south 100 feet and north 160 feet. At present a crosscut also is being driven east into the hanging wall from the 400-foot station, to intersect and open up a series of parallel hanging wall veins which crop out upon the surface.

MÜLLER AND WALLING MINE.

This mine is situated in Wood's Ravine, 1½ miles west of the town of Nevada City. The property lies between, and is parallel to, the Spanish Mine and the northern claim of the Nevada City (Gold Hill) property, and is located upon the contact between the slate and granite formation. The length of the claim is 1,760 feet. This property has been worked only on the surface, the work demonstrating, however, a large ledge, returning from $7 to $14 in free gold, and a considerable percentage of high-grade concentrates, running $100 per ton. A crosscut has been started from the 400-foot level of the Nevada City Mine to intersect this ledge, thus giving over 300 feet of "backs" on the vein.

THE DRIFT GRAVEL MINES—NEVADA CITY MINING DISTRICT.

The drift gravel mines of the Nevada City District are situated along the Washington Ridge, on the ancient river channel, or channels, which underlie it.

While the elevation, or ridge, terminates at Nevada City, the channel extends west of that point nearly 2 miles, a great portion of which has been worked by the hydraulic method, the stripping, or erosion, of the volcanic capping rendering this method especially applicable to this portion of the channel. From the "Sugar Loaf," just north of the town, at the base of which the elevation of the ridge commences, up the ridge for a distance of over 4 miles, there is a succession of mines whose development is progressing rapidly and with satisfactory results. In configuration the ridge is very long and narrow, extending from Nevada City to the northeast some 20 miles into the Washington District; its width varies from ½ to 1 mile.

The channels appear to follow quite closely the course of the ridge; or in other words, the ancient rivers, whose beds lie inclosed, appear to have followed quite closely the direction of the modern streams, which have eroded on either side and produced the ridge. The summit of the ridge is quite regular, and its elevation varies little in its course to the northeast.

From the Manzanita Mine at Nevada City it is doubtful whether the gravel channel could be profitably worked in its course up the ridge by ydraulic method; this fact is due to the deep capping of volcanic

material above this point. As nearly as could be ascertained, the bedrock underlying the ridge has an elevation of 2,650 feet in the Odin Mine, increasing gradually in its course up the ridge; the elevation of the suspension bridge at Nevada City is taken at 2,440 feet.

The strata of gravels, sands, and clays deposited by the ancient river have a depth of about 200 feet; above this the volcanic capping lies, with a depth of 300 to 400 feet. The bedrock is a soft, decomposed granite, containing hard bowlders, varying in size from a foot or two up to 40 or 50 feet in diameter. These bowlders are sometimes intensely hard, costing as high as $12 to $16 per foot to drift through them.

The gravel stratum profitably worked by the drift process is that lying directly upon the bedrock. Its character varies from a fine, free gravel, that admits of the perfect extraction of the gold by sluicing, as was found in the Live Oak and Nebraska claims, to a hard, cemented gravel, found in the deep channel in the West Harmony Mine. In the Harmony gravel large quartz bowlders are found, in many of which gold can be plainly seen. But in all these gradations the gravel proper is composed almost entirely of quartz pebbles, fine dirt, and quartz cobbles. Whenever found in the channel proper the gravel is of high grade, yielding from $2 50 to $13 per ton.

The gold occurs in coarse shots, for the most part disseminated through; no find of nuggets of any size has been heard of by the writer. The gold works its way into the soft bedrock, and in breasting the top 6 inches is taken out with the gravel.

The depth of the gravel stratum extracted varies from 2 to 5 feet in the various portions of the grounds.

It is a somewhat noteworthy fact that all the mines at present in operation are attacking the channels by means of incline shafts with varying angles, and bedrock tunnels extending from the bottom thereof into the channel. This is done in order to avoid a very long tunnel, which would be necessary if opening by tunnel alone were followed, and secondly, to avoid the cost of driving through the excessively hard ground that would be met with when going through the high rims.

The tunnel into the Cold Spring ground, though very small in size, cost as high as $16 per foot for a long distance.

There is little or no water in the ridge; the amount in most mines is trifling, and is readily handled by an ejector using but a few inches of water.

By sinking incline shafts, easy ground is met with all the way, great speed is attained, and the channel is intersected and prospected without the large outlay and long delay that would be occasioned by long bedrock tunnels or probably extremely hard ground. If the channel is found and gravel exists in anything like paying quantities, the high grade can readily stand the small additional cost of extraction due to hoisting and pumping, the less expensive tramming, furthermore, effecting this in part.

A peculiarity noticed in the method of working was the use of augers to put down holes in the bedrock. At times this becomes stiff and tough, making work with the pick slow and laborious, and drilling with hammer and drill slow. By means of sharp augers holes can be bored very rapidly, and by using powder quick progress can be made. It is stated at some mines that a reduction in the cost of labor of nearly one half is effected. The ejectors, or hydraulic elevators, used to free these mines of

the small amount of water that they make, are described in another place.

The Nevada City channel has proved a very rich one in past workings. The Live Oak and Nebraska claims, worked out in the 60's, yielded heavy returns to their owners. It is stated that 3,000 feet of this channel yielded $4,500,000. Since the cessation of operations in these mines, no systematic work has been done, and the rich channel was not discovered until met in the Harmony Mine. It is stated that the Harmony gravel at present returns $10 to $13 per ton when crushed in stamp mills; it is claimed that, with proper economic working, gravel yielding $2 to $2 50 per ton will pay expenses.

The channel in the Harmony Mine is being regularly blocked out, the gangway being kept well into the rim, leaving a pillar between it and the channel extracted. Cross drifts are run every 100 feet, and breast drifts extended into the ground blocked out from every second cross drift. As the roof is poor, the ground is close timbered, and stowed closely whenever excavated. As the bedrock swells rapidly it is found advisable to keep dead work just far enough ahead so as to have a new block ready when the old one is finished, and not before. The swelling bedrock is found in every mine, the intensity of the phenomenon appearing to vary little in the different instances.

It has been found advisable to give the timbers considerable spread, and without making them too heavy, to cut out the floor and sides whenever necessary. Sets with spreaders and made unyielding are always rapidly broken; it is found better to let the floor rise and cut it down whenever necessary. The pressure is different from that due to "heavy" ground, the swelling being gradual and not causing the ground to "curve away" in any quantity, but acting merely as an enlargement of the practically solid ground, and effecting a contraction of the tunnel or other opening.

The great activity and development of the Washington Ridge has all taken place since the beginning of 1891, and apparently is due to the results met with in the Harmony Mine.

The success of these operations appears to be permanent, and to augur well for the prosperity of the Nevada City District.

HARMONY MINE.

The Harmony Drift Gravel Mine is situated 2½ miles northeast of Nevada City, at an elevation of 2,930 feet. The elevation of Nevada City is 2,440 feet. The property contains 215 acres; it has a total extent of 2,400 feet upon the channel.

This channel, the same as that met with in the other mines working on the Washington Ridge, is an ancient river channel, the gravel of which is composed entirely of quartz pebbles and bowlders, lying immediately upon the bedrock, covered with various strata of pipe clay, sand, and different gravels, the top of the deposit being surmounted with a capping of lava and volcanic material.

At the Harmony Mine the quartz gravel worked has a depth of 2 feet, and the top and volcanic capping has a depth of 400 feet. The course of the channel is a little north of east and south of west. The elevation of the top of the deposition above sea-level is 3,270 feet; the elevation of the underlying bedrock is 2,770 feet; the elevation of the hoisting

works above the nearest ravine is between 2,000 and 3,000 feet. The bedrock is a decomposed granite, containing occasional very hard bowlders, which seem to have entirely resisted decomposition.

The mine is opened by an incline shaft, with a tunnel extending from its foot; by this means an excessively long tunnel is avoided, the ground sloping very gradually toward Deer Creek. The incline shaft has a depth on the incline of 330 feet, the angle of inclination being 30°; this shaft is timbered throughout, and cost for labor alone $3 50 per foot. The tunnel extends from the foot of the incline north into the channel. Two channels exist in the upper portion of the ground; the first, or Cold Spring channel, turning to the southeast, and the second, or Harmony channel, turning toward the northeast.

These two channels are very near together when cut by the tunnel, a narrow point of hard bedrock about 75 feet through alone intervening. The first, or Cold Spring channel, is cut at a distance of 710 feet from the foot of the incline, and the second, at a distance of 330 feet north of this first point.

West of the tunnel the two channels seem to have nearly touched, without as yet having merged into one. The Cold Spring channel averages about 100 feet in width, and was worked east of the tunnel a distance of about 300 feet. From the map of the old Harmony workings, which had been driven in from the opposite, or north side of the ridge, it was known that a second channel was ahead, and the tunnel was extended, intersecting it as stated. The Harmony channel has a width of over 200 feet, it having been breasted to this width. A gangway has been driven west upon this channel a distance of 300 feet, and operations are at present being conducted upon this channel alone. This gangway is driven somewhat out in the rim, leaving a pillar of 30 feet of dead ground to protect it. Cross drifts are run across the channel from this gangway at distances of 100 feet, and the ground regularly and systematically breasted, beginning at the far side of the channel and working toward the gangway, and stowing behind with waste dirt.

In order to avoid unnecessary shoveling, breasts about 30 feet wide are carried on each side of every other cross drift; this leaves the intermediate ones with breasts 70 feet wide on each side, which are still further blocked out by running breast drifts into them 50 feet apart and at right angles to the cross drift. Breasting is then begun from the extremities of the breast drifts and carried toward the cross drifts.

The roof in this portion of the mine is poor, being composed of sandy clay and gravel; it is found necessary to keep this by carrying stringers the full length of the breast, driving lagging over the caps to keep the ground. The sets of stringers are 4½ feet apart; the gravel is 2 feet thick, and as a breast 4 to 4½ feet is carried, the waste dirt is stowed, completely filling the space already breasted. About 6 inches of the bedrock is taken up and sent up with the gravel. The bedrock swells very rapidly, and necessitates continual "cutting out," giving the most trouble by swelling from the foot wall. From this fact it has been advisable not to block out ground in advance faster than was absolutely needed, and when once blocked out, to breast it out as rapidly as possible.

The cost of the main bedrock tunnel was $2 25 per foot for labor, except when hard ground was met; in instances this hard ground cost

$10 to $12 per foot; very little was met with, however. The cost of cross drifts is about $2 per foot.

The main tunnel is timbered with arched sets, 3½ feet wide in clear at top and having a spread of about 9 feet, and a height in clear of over 6 feet. The gangway and cross drifts are a little narrower.

The mine is ventilated by a blower; only 3 inches of water is used, and the cost is then very small. Tunneling is done by hand. No powder is used, except when a hard bowlder is met with. The gravel is not tightly cemented, but contains a clay, which renders washing in sluices very inefficient. The gravel being composed of quartz, also containing gold, it was found that in washing less than one half of the gold was recovered. It is now being hauled and milled, pending the completion of the new ten-stamp mill, adjacent to hoisting works, in course of erection.

The percentage of bowlders is under 25, and as these are composed entirely of quartz, are all sent to the mill. About thirty cars of gravel are hoisted per shift, cars holding 1,700 pounds.

Two ten-hour shifts are worked, twelve men on each shift, of which three are carmen. The gravel is very high grade and is yielding from $9 to $11 per car, carloads weighing 1,700 to 1,800 pounds. The gold is .850 fine.

Steam power is used at present for hoisting, wood being cut from the company's ground, and costing $2 to $2 25 per cord; one and one half cords per day are consumed. It is the intention to replace steam by water power throughout. The water from the mine is very light, and comes almost entirely from the old workings; a 6-inch pump on short stroke keeps the mine free. Twenty-four men are employed underground and three on top work. Miners' wages, $2 50 per day.

WEST HARMONY MINE.

The West Harmony Drift Gravel Mine is situated on Washington Ridge, 2 miles northeast of Nevada City. The property contains 180 acres, and 1,600 feet on the channel, extending entirely across the ridge; the altitude of the hoisting works is 2,900 feet.

As in the Harmony Mine, the gravel is composed almost entirely of quartz pebbles and bowlders. In the West Harmony Mine, in the deep channel the gravel is somewhat more cemented than that in the high channel and in the Harmony Mine.

The depth of the gravel worked varies from 2 to 5 feet; the depth of the top gravel and pipe clays, 190 feet; depth of volcanic capping, 410 feet. The course of the channel is northeast and southwest; its width is 200 feet. The elevation of the underlying bedrock above sea-level is 2,700 feet. The fall from the hoisting works into the ravine is several hundred feet. The bedrock is a decomposed granite, usually very soft, but occasionally containing hard bowlders.

The mine is opened by an incline shaft, with tunnel extending from its foot to intersect the channel. The depth of the shaft upon the incline is 576 feet; the angle of inclination is 23°. The cost of labor for sinking incline was $2 95 per foot. The dimensions of the incline are 8 feet by 5 feet in the clear.

The length of the bedrock tunnel from the foot of the incline is 710 feet. The cost per foot for labor in driving tunnel is $2 25.

The dimensions of the main tunnel are: Height, 6 feet; width of cap, 4 feet; width at bottom, 8 feet. Two main gangways are run from the tunnel, the first at a point 510 feet from shaft, and the second at a point 670 feet from shaft. The first gangway cuts the channel 180 feet from the tunnel, and the second cuts the same depth channel in 40 feet.

Ventilation is furnished by a blower; as no blasting is necessary, a 6-inch pipe suffices to carry air.

The channel is divided into two portions, a deeper part, which contains cemented gravel and which would appear to be the main channel, and a higher portion, where the gravel is not so strongly cemented, but is practically free. Both these gravels require crushing in stamp mills, from the fact of the quartz contained, and also the clayey nature of the cementing material of the gravel. The percentage of bowlders in the gravel will reach 25 per cent.

At present the gravel is being blocked out in readiness for the stamp mill in process of erection, therefore the only gravel extracted comes from the dead work being carried on. This gravel is crushed in an arrastra, which does very good work upon the freer gravel, but requires too long a time to reduce the cemented gravel to a fine enough pulp to insure complete extraction of the gold contained. Twenty to thirty carloads of gravel are hoisted per shift, weighing 1,800 pounds per carload. The gold is .845 fine. A ten-stamp gravel mill with double discharge batteries is in course of erection.

The arrastra used has a capacity of 60 to 80 tons per day. It is run at a speed of thirteen revolutions per minute, the four drags weighing from 600 to 800 pounds each. The bottom is paved; the drags are clamped to the arms and are adjustable. Three tons are fed to the charge, and from forty to eighty minutes are required to grind the same, according to the nature of the gravel. The sluice run is 240 feet long, and has a grade of 10 inches to the 12-foot box. The upper part of the sluice is cross-riffled. About 15 inches of water is required to run the arrastra.

There is a very substantial and well-arranged hoisting plant on the mine. There is very little water in the mine, a few carloads only being hoisted every third day. Water power is used throughout, with a steam engine and plant in readiness, in case the water supply should fail. The power water is delivered under a head of 340 feet, and costs 18 cents per inch. At present nineteen men are employed underground, three on top work, and one in the arrastra mill. Miners' wages are $2 50 per day.

ODIN MINE.

The Odin Drift Gravel Mine is situated 1¼ miles north of Nevada City, at an elevation of 2,830 feet. The property consists of two claims, the Nebraska and the Wait-for-the-Wagon, with a total area of 90 acres, and a probable extent upon the channel of 3,000 feet. The elevation of the suspension bridge at Nevada City is 2,440 feet. The deposit, as in the case of the other mines on the Washington Ridge, is an ancient river bed, surmounted with various strata of pipe-clay gravel, or the whole covered with a volcanic capping. The stratum of gravel which will be extracted is that lying immediately on the bedrock. This gravel is composed, as to the solid portions, of pure quartz gravel, with loose cementing material.

The total depth of the volcanic capping and upper gravel is 600 feet; the depth of the gravel where the channel was formerly worked, in the Nebraska ground, was 4 to 5 feet. The elevation of the top of the deposit above sea-level is 3,275 feet; the elevation of the underlying bedrock is 2,665 feet. The nearest ravine is 200 feet below the hoisting works, and affords ample dump. The bedrock is a soft, decomposed granite, containing occasional hard bowlders. The course of the channel in the southern part of the claim is north and south; in the northern portion the course is expected to change, and turn toward the east, giving a northeast and southwest course. The fall of the channel is 4 feet in 100 feet.

The mine is opened by an incline shaft, with a tunnel extending from the foot thereof to intersect the channel. The dimensions of the shaft are 6 feet by 5 feet in the clear, and its depth on the incline is 300 feet, the angle of inclination being 42°. The shaft is entirely in soft ground, and is timbered the entire distance, the cost per foot, including timbering, track, and air pipe, being $4 50. From the bottom of the shaft a tunnel is being run to the channel; the tunnel is, at present, in 190 feet, and it is expected to reach the channel in about 170 feet more. The tunnel has dimensions in the clear of 3½ feet in width at top and 5 feet on bottom, and a height of 5 feet, and cost $3 per foot, including air pipe and track. The underground workings are ventilated by a No. 4 Sturtevant fan. The tunnel is driven by hand, and is, of course, close timbered, being picking ground, with the exception of occasional hard bowlders. Giant powder No. 2 is the explosive used.

The gravel from the channel, in the southern portion of the ground, where a few acres were worked out, was very free, composed almost entirely of fine material, and washes readily. It is expected, however, that as the channel is worked toward the north, a change in the character will take place, whereby an increased percentage of quartz pebbles and cobbles will be encountered, and the free-washing quality somewhat lessened by the appearance of clay as a cementing material.

The plant is operated entirely by water power, delivered under a head of 450 feet. Ten inches of water, costing 18 cents per inch, is sufficient to hoist, run the ejector, and furnish ventilation. The mine is kept clear of water by the use of an ejector, which handles the small quantity with perfect satisfaction.

The timber used is split spruce, costing $1 25 per set, and are, roughly, 8 by 8 and 6 by 6 inches. The source of supply is on the ridge a few miles farther up.

Nine men are at present employed—six in mine, two on top, and a foreman. Wages paid miners are $2 50 per day.

Pelton wheels 4 feet and 10 inches in size, respectively, are used to run hoisting machinery and drive blower.

MANZANITA MINE.

The Manzanita Drift Gravel Mine is situated one half mile north of Nevada City.

The property consists of 160 acres. The gravel deposit is an ancient river channel, the gravel stratum worked lying upon the bedrock and having a capping of top gravel, surmounted with volcanic material. The course of the channel is north and south. The elevation of the top of the deposit is 3,280 feet above sea-level, and the elevation of the under-

lying bedrock is 2,670 feet. The country falls gradually from the hoisting works to Deer Creek, which has an elevation of at least 100 feet lower than the mine.

The bedrock is a decomposed granite, containing occasional hard bowlders. The mine is opened by an incline shaft, with a tunnel extending from the foot thereof to cut the channel. The shaft has an inclination of 12°, and has a total depth of 225 feet; its dimensions are 9 by 6 feet in the clear. The cost of sinking and timbering shaft was $2 70 per foot. The tunnel has a width of 4 feet in the clear at the top and 6 feet at the bottom; the height is about 6 feet. The cost of labor for driving tunnel is about $2 50 per foot.

The workings are ventilated at present by water blast. The water from the mine is pumped by an ejector; this is of somewhat larger size than those in use in the other mines, the power water pipe having a diameter of 2 inches and the upcast 3 inches.

Hoisting is done for the present by a horse whim, all connection being ready to put in water power whenever channel is cut. The tunnel is now in 800 feet from the bottom of the shaft, and it is expected to intersect the channel at any time. Seven men are employed at the mine—three on top work and four underground. Wages paid miners, $2 50 per day.

YOSEMITE MINE.

The Yosemite Drift Gravel Mine is situated 2 miles northeast of Nevada City, at works having an elevation of about 3,000 feet. The property contains 160 acres, and adjoins the Walcott claim on the east and the Tiptop on the south. The course of the channel is supposed to be northeast and southwest on this ground. The hoisting works are about 200 feet above the nearest ravine, affording ample dump. The bedrock is decomposed granite, with occasional very hard bowlders.

The mine is opened by an incline shaft, with a tunnel extending from the foot thereof to intersect the channel. The tunnel is about 35 feet lower than the West Harmony tunnel, and was set from the exposure of the channel on the Harmony workings, so as to be under the channel in the Yosemite ground about 15 feet. The incline shaft is 530 feet in depth, and has an inclination varying from 23° to 23½°. The main tunnel has just been started from the foot of the incline, and is now in about 50 feet; it is expected to meet the tunnel in 100 feet farther. The dimensions of the shaft are 5 feet by 6 feet in the clear, the shaft being in soft ground and timbered throughout. The tunnel is 3½ feet in width at top and 6½ on the bottom, having a height in the clear of 5 feet. In soft ground it costs $2 25 per foot, including timbering.

The mine is ventilated by means of an air blast, a 7-inch air pipe being used. The mine is freed of water by an ejector, which raises water to a drain tunnel 400 feet in length and meeting shaft at a depth of 170 feet on the incline. Water power is used for pumping and hoisting, being delivered at works under a head of 254 feet. A 10-foot hurdy-gurdy wheel generates the power.

The tunnel is at present in a hard bowlder, the ground costing $10 to $12 per foot. Six men were employed at the mine when visited—two on top work and four underground. Ten inches of water is used for water power, costing 18 cents an inch.

FOUNTAIN HEAD MINE.

The Fountain Head Drift Gravel Mine is situated 4 miles northeast of Nevada City, on the northerly side of the Washington Ridge. The property contains 373 acres of ground, and possesses a length upon the channel of at least 4,000 feet. It lies between the Cold Spring and Yerba Buena Mines, the Yerba Buena adjoining it on the east. It is situated on the same ancient river channel with the other drift mines in the Washington Ridge system.

The mine is opened by an incline, sunk at present to a depth of 87 feet, the inclination of the shaft being 40°. It will be necessary to sink the shaft to a depth of 480 feet before starting a bedrock tunnel for the channel. The dimensions of the shaft are 8 feet by 5 feet in the clear; the cost of sinking shaft is $2 75 per foot.

From the very favorable development in the Harmony and West Harmony, it is possible that work on this mine will be soon resumed.

COLD SPRING MINE.

The Cold Spring Drift Gravel Mine lies on the Washington Ridge, 3½ miles northeast of Nevada City. The property contains 425 acres, and comprises a length on the channel of about 4,000 feet. It is situated between the Fountain Head Mine on the east and the Harmony on the west.

The mine is opened by a bedrock tunnel 1,400 feet in length; about 600 feet of this tunnel is in hard ground, costing as high as $16 per foot. The tunnel is 4 feet under the surface of the bedrock, where the channel is intersected. The dimensions of the tunnel are: Height, 6 feet, and width at bottom, 4 feet. The last 200 feet of tunnel is in soft ground, is in poor condition, and would need repairing. Two channels were cut by this tunnel, the first, or southerly one, and the second, or northerly one. There is a difference in elevation between these channels of 24 feet. The course of the channels is nearly east and west. The south channel has a width of 500 feet, and the north about 70 feet. The gravel is very loosely cemented, but would require milling, on account of the quartz contained and the clayey nature of the cementing material. But little work was done on the channel, and the expenditure of a small sum would open up the mine in a good manner.

YERBA BUENA MINE.

The Yerba Buena Mine is situated on the Washington Ridge, 4½ miles northeast of the town of Nevada City. The property contains 250 acres of ground, and adjoins the Fountain Head Mine on the west, containing the same channel that runs through the Fountain Head, Cold Spring, Harmony, West Harmony Mines, etc. This property has never been opened up, but as it is owned largely by the owners of the West Harmony Mine, its development will probably be commenced at an early date.

COLUMBIA HILL MINING DISTRICT.

DELHI MINE.

The Delhi Mine is situated in the Columbia Hill Mining District, on the south bank of the Middle Yuba River, or Grizzly Ridge. The elevation of the mine, taken at office, is 2,900 feet. There are three full-size claims on the property, giving a total length on the vein of 4,500 feet by 600 feet. Columbia Hill, the nearest town, lies 6 miles by road to the south. The Delhi Mine is 18 miles north of Nevada City, freight from this point costing $8 per ton.

The course of the vein is north and south, dipping east at an angle of 80°. The average width of the vein is 7 feet.

The mine is opened by a series of tunnels, four in number, driven from the deep ravine extending into the river opposite Horseshoe Bend. The first tunnel is 230 feet in length, and gave about 150 feet of "backs" on the ore shoot; the second, 200 feet vertically under No. 1, was driven in 1,000 feet; the third, 200 feet vertically under No. 2, is in 1,200 feet; the fourth, 330 feet under No. 3, is in 1,700 feet. The lower tunnels are crosscut for the first portion of their length, running on the vein where it can be economically intersected.

The ore shoot varies in length from 200 to 400 feet; the greatest length of ground stoped in any level is 400 feet. The cost per foot of running tunnels is $11 50 when running through the country, and $7 to $8 when running on vein. The dimensions of the tunnels are 6 by 7 feet, timbered at the mouth for 50 to 100 feet, and when running upon or near the ore shoot.

The lowest tunnel, No. 4, is 80 feet above the level of the river, and the total vertical depth attained on the ore shoot is 890 feet. The ore shoot trends to the north at an angle of nearly 10°. Spruce timber is used in the mine, and is cut in the immediate neigborhood; heavy poles are used, costing 1½ cents in the woods and 2½ cents delivered at the mine. Judson No. 2 powder is the explosive used. Lumber can be procured at the Eureka Lake Company's mill, when running, at a cost of about $11 per thousand feet, or from the Snow Tent Lumber Company, costing $22 per thousand feet, delivered. There is a great deal of water flowing from the mine, about 50 miner's inches flowing from the lower tunnel at present. This heavy flow of water seems to come from the hanging wall, and was encountered when a blocky fissured formation was met with, apparently extending far out into the hanging wall.

Machine drills were used in driving the lower tunnels, a National compressor furnishing compressed air for two Phœnix drills. The company has built 4 miles of road for hauling wood and lumber; it acquired 6 miles of ditch by purchase and owns the right to 200 inches of water. The eighteen-stamp mill is situated at the mouth of the first tunnel; all ore from the lower levels has been hoisted on an open tramway up to the mill.

The character of the ore is a banded quartz, containing coarse free gold, and also arsenical pyrites, copper pyrites, and galena.

The total percentage of mineral is about 4 per cent. The ore is crushed and amalgamated in battery and upon plates, the concentrates being saved upon Frue and Triumph tables. The mill contains eighteen stamps, ten of which weigh 1,000 pounds and eight 800 pounds; the latter are in

two four-stamp batteries. The stamps drop 6 inches, the number of drops varying from eighty-five to ninety per minute. The average tonnage per stamp is 2 tons per twenty-four hours, although this can be increased if desired. The ore is crushed through diagonal slot-punched screens; the four-stamp batteries have vertical screens, and have much lower capacity than the five-stamp batteries with inclined frames.

The plate runs are large and divided into four sections, each being 4 feet long, with a width of 4 feet, except in case of the apron plates, which are a little wider. The ore comes into the mill over grizzlies, the coarse being sent through a Blake crusher into the ore bins, whence it is fed to the batteries in self-feeders. About one third of the amalgam is recovered in the batteries, the balance upon the plates. The concentrates are saved on four Frue and four Triumph feeders, and average $100 per ton. The concentrates are treated in the company's chlorination plant, adjacent to the mill; the cost of chlorination is about $7 per ton, and about 93 per cent of the assay value is recovered. The plant contains one 80 by 12-foot roasting furnace, in two hearths, and with a capacity of 4 tons per day; also, three gasing tubs, capacity 3 tons, and precipitating tanks, two chlorine generators, and all necessary apparatus.

At present all ore above the lowest tunnel has been stoped out. The pay shoot was of good grade and size just above the lowest tunnel, and preparations are being made to put in heavy pumping machinery and sink on the vein. A large station for pumping and hoisting machinery is being cut out in the tunnel just north of the pay shoot; its dimensions will be: Width, 30 feet; length, 50 feet; extreme height, 30 feet. As the company owns its water power, and can deliver it at the tunnel under a head of 1,000 feet if desirable, it has decided to put in compressors at the mouth of the lowest tunnel, and raise the water to the tunnel level by means of steam pumps, operated by compressed air. Two No. 10 Dean pumps will be put in, and will be able to handle the water under all circumstances.

ENTERPRISE MINE.

The Enterprise Mine is situated on two veins parallel to the Delhi vein, and lying 900 feet to the west. The Enterprise Mine has therefore an altitude of 2,900 feet, and is, like the Delhi, situated on the north slope of Grizzly Ridge, above the Middle Yuba River. The property comprises four locations, and has a length on the lode of 3,000 feet, varying in width from 800 to 1,200 feet. The two veins are parallel, lying 100 feet apart; their course is north and south, dipping east at an angle of 80°. These two veins lie in the black slate. The eastern is known as the Excelsior vein, and the western as the Enterprise.

The Excelsior vein is opened by a tunnel on the same level as the Delhi No. 1 tunnel. It is driven in the vein 700 feet, and gives a vertical depth on the vein of 150 feet. Three ore shoots are met with in this tunnel, the first, nearest the mouth, 150 feet long, with two inside shoots, each about 50 feet wide. The average width of the vein is about 8 feet. Some very good ore, it is stated, was taken out of these workings. At present a crosscut is being driven from the Enterprise tunnel 200 feet deeper, in order to intersect the Excelsior vein. Four men are at present working in this crosscut. The cost of driving the Excelsior tunnel was about $2 50 per foot. All is soft ground and all timbered.

There are two tunnels upon the Enterprise vein. The lower one is in

700 feet, and cost $3 per foot to drive. The ore shoots encountered are not long, and altogether foot up to a total of 200 feet. The upper Enterprise tunnel is in about 800 feet. These ore shoots all trend north toward the river.

Spruce and pine poles are used, costing 2½ cents per running foot at mine. Judson No. 2 powder is the explosive used. The mine is ventilated by means of a water blast. Waste water from the Delhi is turned down a pipe into a receiver at the bottom; the blast thus generated is carried in by air pipes. The character of ore is the same as that from the Delhi. In addition to coarse, heavy gold, the quartz contains arsenical pyrite, copper pyrite, galena, and blende. The ore is trammed from the Enterprise Mine to the Delhi Mill, where it is crushed. At present four men are engaged in driving crosscut to the Excelsior vein. Wages paid miners, $3 per day.

ST. GOTHARD MINE.

The St. Gothard Mine is situated in the Columbia Hill Mining District, on Grizzly Ridge, at an elevation of 3,220 feet. The mine, comprising two full-length claims, is situated on the south bank of the Middle Yuba River, on the summit of the ridge. The course of the vein is north and south, dipping east at an angle of 80°. The average width of this vein is from 1 to 2 feet. The formation is slate on both walls.

The mine is opened by a vertical shaft in connection with a drain tunnel 1,100 feet in length. The shaft has a total depth of 280 feet; the dimensions are 5 by 10 feet in the clear; timbered its entire depth. The drain tunnel intersects the shaft at a point 180 feet from the surface. There are two levels from the main shaft. The drain tunnel forms the upper level; the lower level extends north 600 feet and south 400 feet. The mine below this drain tunnel is cleared of water by a No. 4½ Deane steam pump. Timber is abundant on the ground. Lumber is procured from Snow Tent at a cost of $22 50 per thousand feet. Hercules No. 2 powder is the explosive used.

There is a substantial steam hoisting and pumping plant on the property. The ore is hoisted on a cage, the work being done by a thirty horse-power duplex hoisting engine; but one cord of wood is used per day in hoisting and pumping. Nine men are employed—six underground and three on top. Preparations are at present being made to sink the shaft 120 feet farther, thus attaining a total depth of 400 feet.

In addition to the above-described work, there are two tunnels on the vein, driving in from the north side of the ridge distances of 500 and 600 feet, respectively.

GRIZZLY RIDGE MINE.

The Grizzly Ridge, or McAusland, Mine is situated on the south bank of the Middle Yuba River, at an altitude of 2,500 feet. It lies 1 mile west of the Delhi Mine, and like it is on the slope of the Grizzly Ridge, in the cañon of the Yuba. The course of the vein is north and south, dipping east at an angle of about 70°. There is one main vein, with hanging wall and foot wall veins coming nearly together, going into the hill; all lie in a highly metamorphic black slate in both foot and hanging walls. The hanging wall vein varies in size from 6 inches to 1 foot;

it joins the main vein going into the hill, and forms the hanging wall portion of the main vein. This hanging portion is remarkably rich, showing coarse, heavy gold "specimens," plainly visible in the ledge, intermingled with a large percentage of very fine sulphurets.

But little work has as yet been done on the property, the present opening, outside of surface cuts, consisting of a tunnel on the main ledge about 80 feet in length, and attaining a vertical depth of about 80 feet at the end. The tunnel is in ore the entire distance, with a 2-foot ledge in the breast. Timber is plentiful on the claim. Sawed lumber costs $22 50 per thousand feet at top of hill. The tunnel will cost about $5 per foot to drive. There is as yet no means of transporting ore, or any facilities for crushing the same. It is probable that the erection of a mill will soon take place. The discovery is of recent date. Three men were at work at time of visit getting the tunnel in readiness to drive farther into the hill.

EUREKA MINING DISTRICT.

The Eureka Mining District lies in the neighborhood of the town of Graniteville, at a very considerable elevation, varying from 4,000 to 5,500 feet. The veins of the district are uniformly large. Those on the contact between the granite and slate formations seem to be of larger size and of better grade and continuity than the others. The quartz is usually vitreous, glassy, free-milling, and easily crushed. Little or no sulphurets are contained. The grade of the ore would seem to vary largely within neighboring portions of the vein. The altitude interferes considerably with operations, on account of the early and heavy snowfalls.

GASTON RIDGE MINE.

This mine, locally known as the California, is situated 4 miles southeast of Graniteville, at an altitude of 4,880 feet. The dimensions of the property are 3,000 by 600 feet. The mine is 32 miles distant from Nevada City, the nearest railroad point. The cost of freight is $12 per ton to Graniteville, and the added charge from this point to the mine will bring it up to the neighborhood of $20 per ton, or 1 cent per pound.

The vein courses north and south approximately. It dips to the east at an angle of 45° to 50°. The width of the vein varies in different portions of the mine. In the upper tunnel it has a width of from 3 to 5 feet, and in the lower tunnel it maintains a size of 10 to 16 feet for some distance, and in other places 4 to 6 feet. The average width of the vein throughout the workings may be set down as 6 to 8 feet.

The mine is opened by a series of tunnels. The upper tunnel, in which the present operations are being carried on, has a length of 700 feet, starting in the foot wall and cutting the vein at a vertical depth of 225 feet. The cost of the tunnel is but $2 per foot, while the mean cost of stoping will be 30 to 35 cents per ton. Ventilation is afforded by a raise from the upper tunnel to the surface. The lower tunnel is in hard ground, and costs $5 per foot to run.

From the location of the mine it will be possible to bring in a much lower tunnel, 350 to 400 feet under the present lowest one. This will open up a large amount of ore, but the cost would be very considerable, probably between $10,000 and $15,000.

The ore from the upper level is carried around 600 feet on a tramway, when it is dumped in a bin, broken to suitable size, and sent by a chute into the mill. The ore is a glassy, vitreous quartz, easily crushed, and contains little mineral. The gold is usually fine, but at times coarse gold has been met with. The ore is reduced in the ten-stamp mill, situated below the North Bloomfield ditch, and at such an elevation that the ore from the lowest tunnel can be run into it upon a curved tramway. The stamps weigh 750 pounds, drop 6 inches ninety-two times per minute, and crush through No. 8 slot-punched screens. The capacity of the mill is 25 tons per day. There is an excellent plate run, 4 feet wide and 16 feet in length. No concentrators are used, but the tailings are run over blankets.

Under the present ownership the property has produced $140,000. The mine has practically been worked only on the outcrop; the greatest vertical depth attained on the south shoot, the only one worked at date, being considerably less than 200 feet.

The mill is run by steam power, three cords of wood per day, costing $3 per cord, being used. A 12-inch engine, with large boilers, runs the mill and grinding pans, of which there are several.

NATIONAL MINE.

The National Mine is situated on the northerly slope of Backbone Ridge, 1½ miles west of Graniteville. The dimensions of the property are 1,500 by 600 feet. The course of the vein is north and south, dipping east at an angle of 80°; the average width of the vein is 3 feet. The vein lies in black slate. It is a noteworthy fact that the ore shoot trends or pitches to the south, which is in opposition to the usual rule in these cases. It is stated that this also occurs in other mines in the Eureka District.

The mine is opened by a tunnel and shaft, the shaft being located at the mouth of the tunnel, through which the upper portion of the ore shoot was worked. The tunnel has a length of 400 feet, intersecting the shoot at a point 180 feet from the mouth. The length of the shoot on this level was 200 feet. Everything above the tunnel has been stoped out a distance of 160 feet to surface. The ledge runs with the lamination or strike of the slate formation. The total cost of driving the tunnel, for labor and supplies, is $3 50 per foot. The ledge continues on to the south, but was of too low grade to admit of profitable extraction beyond the pay shoot. This upper tunnel is timbered throughout the greater part of its length.

The incline shaft is sunk a distance of 100 feet below the tunnel level; from the foot a drift is being pushed to intersect the pay shoot, which, it is expected, will be met in something less than 200 feet. The cost of sinking the shaft was $7 per foot for labor and supplies. The dimensions are 5 feet by 8 feet in the clear. The cost of driving the first level, now in 160 feet, is $5 per foot, the figure including labor and supplies. The dirt is hoisted in buckets, containing 500 pounds to the load. The small quantity of water coming in, between 1 and 2 inches, is handled by an ejector.

The ejector, described fully elsewhere, was first designed and used in this mine. To the engineer, Mr. Rounder, belongs the credit of introducing this invention, now widely copied and used around Nevada

City. It was stated that about 4 inches of water, under a head of 280 feet, was required to effect the elevation of the water. The power pipe was 1½ inches in size, and the discharge, or ascent pipe, 2½ inches.

Ventilation is effected at present by a blower, until a raise is put through the first level to the tunnel. Hercules No. 2 is the explosive used. Lumber is brought from the Snow Tent Company, 7 miles distant, and costs $20 per thousand feet. Timber is found in abundance on the property, and costs merely the expense of felling and bringing in.

The ore is a rather soft, easily broken quartz, seamed with black slate, and containing little mineral outside of free gold. The cost of mining and milling when working through the tunnel was very low, the total being in the neighborhood of $1 50 per ton, $2 ore yielding a profit. Working through the shaft, this figure will be raised probably $1 per ton. The ore is milled in a Huntington mill, contained in a large and well-arranged building near the mouth of the tunnel. The ore falls upon grizzlies, the coarser portion passing through a Gates crusher. There are not enough sulphurets to pay for saving. The building is ample in size, with room for three Huntington mills, should they be needed. The mill crushes 21 tons of ore per day, and but one man on each shift is required for the entire care of the mill.

The hoisting works are of ample size, and were erected to contain heavy machinery, should this be needed. The ore dumps from the bucket into a large bin, whence it falls into cars. The entire plant is run by water power, under a head of 180 feet. Ten inches are required for hoisting works entire, and 13 inches for the mill. Water is taken from the Eureka Lake ditch with a short pipe-line. At present eight men are employed—three on top and five underground. Wages paid miners, $2 per day and board.

ROCKY GLEN MINE.

The Rocky Glen Mine is situated in the Eureka Mining District, 1¼ miles south of Graniteville, at an elevation of 4,700 feet. There are four veins on the property, whose dimensions are 4,000 by 600 feet. The mine has been shut down for some time, but lately changed hands. The new owners have inaugurated some prospecting, with the intention of working the mine with a full force when the developments will warrant it.

Prospecting operations are in progress in the south Stacey tunnel, a raise being put through to surface in the hope of finding a body with pay ore above this point. The Stacey tunnels are timbered throughout, and cost $2 50 per foot to run. Ventilation is afforded by a blower. Two men are engaged in the present work.

The property also comprises a ten-stamp mill in first-class condition, which is run with water power, the water being delivered at the mill under a head of 200 feet.

ERIE MINE.

The Erie Mine is situated 3 miles southeast of Graniteville. This mine formerly was worked on a large scale and paid handsomely. Of late years operations have been confined to prospecting on a small scale.

NORTH BLOOMFIELD MINING DISTRICT.

DERBEC DRIFT GRAVEL MINE.

The Derbec Drift Gravel Mine is situated in the North Bloomfield Mining District, 1 mile north of the town of North Bloomfield, at an elevation of 3,850 feet. The property comprises a consolidation of several placer claims, with a total extent of 641 acres.

The deposit is an ancient river channel, whose course was somewhat devious, but in a general easterly direction. The gravel deposit has a total depth, at the shaft, of 415 feet, with a volcanic covering 60 feet in depth. The stratum extracted, lying upon the bedrock, varies in depth from 6 to 18 feet. The width of the pay channel varies greatly. At times the gravel was breasted a width of over 600 feet, while at other points the width was as low as 150 feet. The elevation of the top of the deposit is 3,780 feet, that of the underlying bedrock is 3,370 feet. The bedrock is for the most part a black slate, with occasional patches of syenite. There is little tendency to "swelling" ground, though at times this occurs to a considerable extent. The mine is thoroughly opened for extraction of gravel, ventilation, and drainage. A vertical working shaft 475 feet in depth, at which the hoisting works are situated, is the main opening, and through it all the ore is raised, the main bedrock tunnel starting from its foot and running up the channel. At a point about 4,500 feet from the foot of the shaft, there is an upraise to the surface, which provides an escape for the men, in case of any cave in the tunnel between the workings and the shaft. The airway is connected with this raise. A drain tunnel 5,000 feet in length extends from the town of Bloomfield and connects with the bottom of the shaft. This relieves the mine of all its water, and provides an additional means of escape. As a result of all these connections with the surface, the ventilation is excellent and far superior to that which could be produced by any artificial means.

Cross drifts were run from the tunnel into the main pay channel to the west, and the gravel breasted out. The airway was carried on the east side of the tunnel; it cost $2 25 per foot. The tunnel extended over 5,000 feet on the channel. Above this point the channel appeared to be broken up, and prospecting for several hundred feet failed to reveal pay ground. It was then decided to begin at the end of the tunnel and work back to the shaft, breasting out the pillars that had been left for the support of the tunnel. This operation is in progress now. The roof in the mine has always been bad and requires careful timbering. The tunnel has a heavy grade, and the transportation of ore to shaft, and timber, or to breast, comprises a large part of the labor underground. The ore cars hold 1,500 pounds.

The hoisting shaft is well arranged and equipped. The shaft is vertical, and cages are used. The empty cage goes down when the loaded one comes up. Safety cages are provided, and a bonnet covers each compartment while the cage is down. On account of the poor roof the timbering is heavy. Pine, spruce, cedar, and fir poles are used, costing ½ cent per running foot, the diameter being from 7 inches up. Split sets for the tunnel are bought at the same rate, the smallest dimensions being 9 by 9 inches. Lumber costs $17 per thousand feet, delivered.

No. 2 Granite powder is used; about one quarter of a pound to each carload of gravel, or one third of a pound to the ton.

The pay gravel is not cemented, but is practically a fine gravel. The percentage of bowlders is large, and in the main pay channel will not fall far under 50 per cent. At present 75 carloads are extracted per shift, two ten-hour shifts being worked. The gold recovered is .900 fine. The average yield per carload has run as high as $2 60, but is a little less now. The gold is extracted by washing. The first washing is through 600 feet of flume, the tailings being impounded by a brush dam. in order to allow them to "slack" completely. When this has taken place the dam is cut and the tailings sluiced into a flume 4,000 feet in length. About 10 per cent is added to the yield from the first washing. The tailings are again caught below this flume in a succession of impounding dams. The grade of the creek along which the flume is laid admits of several falls of 10 or 12 feet, which are effective in completely disintegrating any cemented material. The flumes are 2 feet wide and 2 feet deep, with a grade of 11 inches to each 12 feet. Monitors are used on the washing dump, and 200 inches of water is employed in the operation. About 1,500 tons are washed at a time, the operation requiring two days. A clean-up is made twice a month.

In addition to the main washing dump there is a small one used for prospecting the gravel from different parts of the mine. The tailings from the small washing dump flow into the main flume.

Hoisting is done by steam power, the hoisting works being commodious and well equipped. A forty horse-power engine does the work, with two large boilers for steam purposes. Flat cables are used. Three cords of wood are consumed per day, costing $3 35 per cord, delivered. At present twenty-four men per shift are employed underground, and a total of eight on top. Miners' wages, $2 50 per day; timbermen, $3.

Operations at the time of visit were confined to the breasting out of the pillars along the far end of the tunnel. A very important prospect drift was being run east of the tunnel by the Superintendent, and with apparently excellent outlook and result. This leads into an entirely new piece of ground, and would open up a large portion of the channel, or a channel, upon which nothing has as yet been done. An excellent breast of apparently high-grade gravel was shown in the face of the drift.

MARBLE.

On the South Yuba River, about 3 miles east from North Bloomfield, there has been located by Harmon & Co. a large deposit of marble. The belt shows very plainly up and down the south bank of the cañon, but is covered up on the north side of the river. A black, mottled marble of beautiful texture and appearance is produced, which takes readily a high polish, and appears to be very desirable for ornamental purposes. This belt runs nearly north and south, and lies 1 mile to the east of a large limestone formation. The belt has a width of 100 feet, of which fully one half is a marble of excellent quality.

SPENCEVILLE MINING DISTRICT.

The Spenceville Mining District is situated in the neighborhood of the town of Spenceville, 17 miles southwest of Grass Valley. This district varies radically from the others in the county, in the large percentage of copper present in all its ores—most of which could be worked for copper alone—containing neither gold nor silver. Copper runs from 1½ to 10 per cent.

The formation in this district is granite in one portion, with diabase and slaty rocks on the west of the granite. The contact between the two distinct formations passes in a northwesterly and southeasterly direction through the town of Spenceville. The copper mines occur near the border of this contact; the Spenceville Mine lying in the diabase, a short distance west of the contact. The greater number of the mines lie north of the town of Spenceville, a distance of 3 to 4 miles. The ores in this portion of the district seem to carry a small amount of gold, the veins varying from the Spenceville Mine. These latter properties have not been worked to any extent for some time, although their ores would seem to contain a considerable percentage of copper.

SPENCEVILLE COPPER MINE.

This mine is situated in the town of Spenceville, 17 miles southwest of Grass Valley, at an elevation of 450 feet. The property contains 220 acres of land. The ore deposit occurs in a diabase formation, near the contact between it and the adjoining granite and which lies a few hundred feet to the east. The course of the ore deposit is from northeast to southeast parallel to the strike of the contact. The foot wall dips northeasterly at an angle of 95°. No hanging wall is yet shown in the workings. The ore deposit took the form of an ore body, 230 feet in length as far as worked, and 40 feet in width; the width of the vein itself is unknown. The ore body was worked to a depth of 150 feet. Analyses of the ore were published in the last report.

A great many thousand tons of ore were extracted and roasted in piles, the copper being extracted by leaching after the roasting. The process was very imperfect and wasteful, but 46 per cent of the total copper contained being recovered. A large body of compact pyrite, containing from 1 to 2 per cent of copper, was left in the mine as low grade; this body extends from the grass roots down. The dump of ore from the old working is a very large one. It is over 200 feet long, 80 feet high, and 100 feet through. As stated, about 2 per cent of copper, or a little over, was left on the dump. This is now being extracted very economically by leaching with water and precipitation upon scrap iron. Water is sprayed upon the top of the dump in various places, which, working its way through, is collected at the bottom and run into a large trough; this solution is heavily charged with sulphates of iron and copper. The copper in solution is precipitated upon scrap iron placed in the trough, which is 2 feet wide and 1 foot deep. A deep riffle is put in every 40 feet to settle the cement; the scrap is placed near the riffle, leaving the lower portion of each space free for the perfect precipitation and settling of the cement. The scrap is turned and brushed off twice each day. The cement settles and is cleaned up twice a month, when the scrap is thrown out and washed off. The cement is then worked through

a 30-mesh screen into settling vats, dried and shipped. It could be melted into bars if desired.

The cement contains 80 per cent copper, the resulting bars being .998 fine, and equal to the best lake copper. The sluice run is 1,000 feet in length. The lower portion of the sluice is only cleaned up occasionally, and yields a 60 per cent cement. In summer, when water fails, which is about three months during the year, water is hoisted in buckets from the open pit and run through the sluice. The mine water is nearly as heavily charged as the water from the dump. After the copper has been leached out the material is converted into a very excellent metallic paint. The fine material is washed in vats with stirrers and all coarse fragments removed. It is then dried, calcined in a reverberatory furnace, and ground in a paint mill. The resultant product possesses an excellent color and is far superior in quality, composition, and preservative effects to any of the metallic paints imported from the East. Its composition is as follows:

Peroxide of iron	76.50
Alumina	4.30
Silica and insoluble matter	14.65
Moisture (combined)	4.40
Lime, magnesia, and loss	.15
	100.00

For rough work this paint can be put on with a mixture of three fourths water and one fourth oil; when put on with this small proportion of oil it will not rub in the least. The entire dump is available for the manufacture of paint after the copper has been leached.

SMARTSVILLE MINING DISTRICT.

Upon the cessation of hydraulic mining, consequent to decisions of the Courts, upon the well-known gravel channel running from the Yuba River through Timbuctoo to Sucker and Mooney Flats, the mining industry for a time was entirely dormant in this section of Yuba and Nevada Counties. Afterward, through the energy and enterprise of Mr. Henry Wheaton, at that time Superintendent of the Excelsior Land and Water Company, an attempt was made to work the hard cement gravel stratum lying on the bedrock by the drift process. The gold in this channel is universally fine and disseminated through the entire body of gravel, nuggets of any size being unknown. As a consequence, while some strata are richer than others, the richest are low grade compared with the gravel extracted from drift channels wherein the larger proportion of the gold is found on or near the bedrock; therefore, careful working and economic methods are necessary to render the working profitable. The first attempt was unsuccessful, from the fact that the grade of the gravel would not admit of reduction in stamp mills at a profit; but the subsequent substitution of arrastras for stamps, whereby the cost of milling was greatly reduced and apparently an increased percentage of recovery effected, it has been found possible to work the lower bedrock strata at a profit. It is beyond doubt that the free water power owned by the companies and used by them in their operations contributed greatly to a successful result.

THE ARRASTRA PROCESS OF MILLING.

The arrastras in use at Smartsville and Mooney Flat contain the principle of the original arrastra, adapted to its operation and handling by water or steam power. The arrastras are 12 feet in diameter and 3 feet deep. The bottoms are paved with hard rock roughly dressed, and in such manner as to present as even a surface as possible, and laid in cement, the paving being 16 inches in depth. The post in the center is 14 inches square and 18 inches high, carrying the mast with four arms, to each of which a heavy drag is attached. The motive power is transmitted either by means of a large horizontal pulley, through whose center the mast passes and upon which a belt runs, or by means of a toothed gear fixed in a circle around the nearest and into which a pinion works. This last is the preferable arrangement. The drags are heavy blocks of diabase hung to the arms by means of chains and clamps, and so arranged that all portions of the pit are traversed by them when they are rotated. They weigh from 600 to 1,200 pounds. To charge the arrastra gravel is either run in from a car, or, better, from a chute; 5 to 9 tons constitute a charge. While the charge is being introduced the speed is lowered, water being added from time to time in order to prevent the charge from caking. A large quantity of water is taken up, and the charge finally has the consistency of thin paste. The arrastra is speeded up to fourteen revolutions a minute; in the case of hard cement this is kept up one hour. It is discharged by opening a gate in the arrastra, which empties directly into the sluice containing the riffles. The charge runs itself out, water being added to facilitate the discharge. By a judicious mixture of "sharp" or crushed gravel and the ordinary gravel that has gone through the grizzly and has not required crushing, it is remarkable what a thorough grinding and pulping the gravel receives from the process. About one tablespoonful of quicksilver is added to each charge, the loss in quicksilver falling below 10 per cent. The sluice run is nearly 200 feet long, the boxes containing for the most part the ordinary longitudinal riffles. The sets nearest the arrastra, however, have the cross riffles, and likewise the last sets in the run. The sluices are cleaned up once a week. Almost the whole of the amalgam will be found in the first cross riffles near the arrastra, very little getting farther down the sluice. When running off the charge about 30 inches of water is required. Drags last six weeks, and cost about $5 apiece. A new bottom costs $40, and lasts about six months. The capacity of one arrastra on hard cement is 50 tons per day; on soft "top gravel," 75 to 90 tons per day.

The advantages of this process consist in the low first cost of the plant, in its simplicity and that of its mechanical devices, in the extreme cheapness of the cost of treatment, and in the apparent effectiveness of the process itself. When suitably arranged, as in the Wheaton plant in Mooney Flat, the gravel is dumped upon the grizzlies, the coarse going through the Gates crusher, which is superior for this work. The "sharp" and "dull" gravels are then in two separate bins, centrally situated, from which they can be dumped into the arrastras by means of chutes. One man per shift can thus fill, run, and discharge four arrastras, being the only man in the mill, with the exception of a rock breaker. The cost of labor amounts to but a few cents per ton.

The Smartsville gravel is especially adapted to treatment in arrastras,

none of the precious contents being contained in the hard portion of the gravel, which would require long continued attrition to reduce to pulp. Every portion of the gravel carrying the gold is almost immediately reduced to a pulpy paste, and in this manner the arrastra avoids the performance of a large amount of unnecessary work, and effects a comparatively perfect saving of the gold, the grinding process tending to brighten and render amalgamable any "rusty" gold far more than the ordinary crushing through a cement stamp mill. The cost of milling in arrastras under proper conditions is 6 to 8 cents per ton; by stamps this would be 25 to 40 cents per ton.

MOONEY FLAT DRIFT GRAVEL MINE.

This mine is located in Mooney Flat, on the extension property of the Excelsior Company, 2 miles east of Smartsville and 20 miles from Marysville. It is situated on the northern extremity of the well-known Timbuctoo blue gravel channel. The success of operations in the Blue Point mines in Sucker Flat led to the inauguration of work at this point. The gravel deposit is an ancient vein channel of large size.

The mine is opened by a vertical shaft situated upon a sharp bend of the channel. There is no capping, the gravel coming to the grass roots. The shaft is thus sunk through gravel its entire depth, the body being 70 feet deep at the point where the hoisting works are situated. This depth of gravel increases rapidly going to the west, and 1 mile distant it has a depth of between 200 and 300 feet. The course of the channel where the shaft is situated is nearly east and west. The gravel extracted from the bedrock stratum is hoisted to the surface and milled in arrastras, the tailings dumping ultimately into the Yuba River, about 300 feet lower and 1 mile to the east. It is necessary to blast all the lower strata, and, consequently, all gravel extracted. The bedrock is a hard, compact diabase. The cost of sinking the vertical shaft was about $5 per foot. Channel drifts are run both ways from the bottom of the shaft, extending west 600 feet and northeast 90 feet. These main drifts are 7 feet by 4½ feet in the clear, and cost $2 to $3 per foot. The mine is ventilated by blower alone, and no airways are used. Power is free.

The gravel is for the most part a hard, cemented, blue gravel. The best gravel has been found on the east vein, the main channel being of lower grade. The breast of gravel extracted varies from 4 to 6 feet. There is a heavy percentage of bowlders, averaging fully one half. At present thirty-five carloads are extracted per shift of one half ton each. The mine at time of visit was working only on the day shift, nine men being employed. Hercules No. 2 powder is the explosive used. The gravel averages $1 25 to $1 50 per carload, weighing one half ton; the gold has a fineness of $18 to $19 per ounce.

Water from the mine is very light; a 6-inch pump runs three hours per shift. The company's ditch furnishes free water power, which is delivered at the mine under a pressure of 150 feet. Pelton wheels are used to generate power.

YOU BET MINING DISTRICT.

The You Bet Mining District lies in the southern portion of Nevada County, along its eastern boundary with Placer County. This is essentially a hydraulic mining district, no quartz veins of magnitude in value having been discovered within its limits. A large portion of its surface is composed of gravel and volcanic capping. The rock formation changes from a diabase toward Grass Valley in the west, to a slate going east. The operations in drift mining in You Bet and the neighboring towns have been very considerable in the past, but little is being done in any branch of the mining industry at present.

GOODWIN MINE.

The Goodwin Drift Gravel Mine is located at the town of You Bet, 10 miles east of Grass Valley. You Bet Station, on the Nevada County Narrow Gauge Railroad, is distant 4 miles, and is the nearest railroad point.

The property consists of a large tract of hydraulic ground, which would be very valuable if hydraulic mining is resumed. One portion contains a channel that has yielded good returns in the past. The amount of land comprised in the individual block is 80 acres.

The deposit is an ancient river channel. The bedrock stratum alone is worked. The stratum worked has an average depth of 6 feet, about 15 inches of the bedrock being taken out with the gravel, except when the bedrock is exceptionally hard. The course of the channel is nearly north and south, the same channel extending continuously through Quaker Hill and Scott's Flat, and having an extent through its various workings of 15 miles. The bedrock is a soft, laminated black slate.

The mine is opened by an incline shaft 220 feet in depth and having an inclination of 35°. Drifts are run from the bottom of the incline both north and south, up and down the channels. The north channel drift extends about 700 feet, the channel having been stoped out the entire distance. The south drifts extend about 800 feet into that portion of the claim which has been hydraulicked to bedrock. The drifts have dimensions of 5 feet by 6 feet in the clear, and cost $2 50 per foot to run. By thus penetrating into the hydraulic workings excellent ventilation is obtained.

The gravel is a hard, cemented, blue gravel, and contains, in the channel, a considerable proportion of bowlders, amounting to about 25 per cent. The channel worked is the deeper portion of the main channel, varying from 50 to 100 feet in width, with an average of 70 feet. The gravel is crushed in a ten-stamp cement mill contained in the hoisting works structure. The stamps weigh 900 pounds and fall 7 inches. The capacity of the mill is $5\frac{6}{10}$ tons of gravel per stamp in twenty-four hours. The ore is crushed through round-punched screens.

Spruce and pine poles, 12 to 15 inches in diameter, are used in the mine. When cut in suitable lengths for timbering they cost 25 cents per set. Water power is used in all operations, being obtained under a head of 175 feet, from the ditch owned by the property. The ditch is known as the Steep Hollow Ditch, has its own water right, and is 12 miles in length. At present operations in the mine are confined to

prospecting in the southern portion of the grounds. Six men are employed in the works. Miners' wages, $2 50 per day.

GOUGE-EYE MINE.

The property is an ancient river channel, of which the lower bedrock stratum is worked. The mine is situated at Hunt's Hill, 3½ miles north of You Bet. The width of the channel worked varies from 60 to 100 feet.

The mine is opened by a tunnel, and has been worked in the channel for a distance of between 500 and 600 feet. The workings are now within less than 200 feet of the Sargent & Jacobs line. The property is owned and worked by Chinamen, and it was impossible to ascertain anything definite about the gravel, except that the property was supposed to pay handsomely, notwithstanding the imperfect method of extraction of the gold. The gravel, which is considerably cemented, is thrown out along the sluice and exposed to the action of the air until it slacks somewhat. It is then washed, and the tailings caught and subjected to the same process repeatedly. With gravel of this nature the method is slow, expensive, and doubtless imperfect. Twenty men are employed; all Chinamen.

MAINE AND EAST MINE.

The Maine and East Mine is at Hunt's Hill, 3½ miles from Nevada City. The property contains 1,300 feet of the channel. The gravel has a total depth of 200 feet, of which the lowest, or bedrock, stratum is suitable for drifting, having an average depth of 6 feet. The width of the channel breasted is from 60 to 120 feet. The bedrock is a soft black slate.

The mine has been worked as a hydraulic mine, with a result that the soft high gravel has been removed and the hard blue gravel left. A ten-stamp mill is in course of erection, and the extraction of gravel will begin as soon as it is in running order.

SARGENT & JACOBS MINE.

This property adjoins the Gouge-Eye Mine on the north. It was one of the largest and best of the hydraulic mines, but has been continuously shut down since the suppression of the hydraulic industry. It is hoped that the success of the adjoining property worked by the drift process will induce similar operations in this mine.

PLACER COUNTY.

By W. L. Watts, Assistant in the Field.

THE WELLS OF THE VALLEY LANDS.

Around Wheatland water is obtained from bored wells in strata of sand and gravel at a depth of about 100 feet, and there are many dug wells from 35 to 40 feet in depth.

The Wheatland Waterworks pump water from a shaft 30 feet deep and 5 feet in diameter, and in this shaft three wells have been bored to a depth of 106 feet. About 30 feet from the shaft a fourth well was bored to a depth of 175 feet, and this is connected by a drift with the shaft above mentioned. About 60,000 gallons is daily pumped by the waterworks during the summer, without exhausting the supply. Prolonged pumping, with a pump throwing a 5-inch stream, lowered the water to a depth of 22 feet from the surface. As an experiment, a smaller casing was inserted in the 6-inch 175-foot well, and the boring was continued to a depth of 550 feet; the formation showed:

Soil, yellowish clay loam (noted in the old well)	14 feet.
Gravel and cobblestones, with water	6 feet.
Yellow clay	85 feet.
Sand and gravel, with water	4 feet.
Alternate strata of clay and gravel, the latter yielding water	190 feet.
Blue clay, with a few thin strata of sand and gravel	251 feet.

At this depth a vein of highly mineralized water was struck.

Around Sheridan the wells are generally dug to a depth of from 30 to 35 feet, or bored to a depth of from 50 to 60 feet; both yield a good supply of water. Two attempts have been made to obtain flowing wells in Sheridan, and the results, although not entirely successful, have been sufficient to warrant a further prosecution of the work. The first was in the spring of 1891, at the Sheridan school house, and the second was at the ranch of N. Luce, about 2 miles southwest of Sheridan. The school house well is 734 feet deep; the formation penetrated is as follows:

Red clay loam	1 foot.
Hardpan	6 feet.
Grayish clay	290 feet.
Seepage water was observed at 48 feet.	
Quicksand, with water, which rose 6 or 8 feet in the casing	4 feet.
Alternate strata of yellow, red, blue, and white clay	100 feet.
Hard stratum of cement	8 feet.
Alternate strata of variously colored clay	190 feet.
Hard stratum of cement	3 feet.
Small stratum of gravel, with some water, which rose 30 feet	1 foot.
Alternate strata of variously colored clay	50 feet.
Hard stratum of cement rock	1 foot.
Alternate strata of variously colored clay	78 feet.
Crystallized quartz	1 foot.
Quicksand, with water, penetrated	1 foot.

The water stood at a depth of 19 feet.

This well is situated upon a hill about 25 feet above the railroad depot at Sheridan, and the inference is that had the well been bored at the depot, flowing water would have been obtained. The well was cased for the first 300 feet. Below that depth the boring stood without casing until the quicksand was struck.

The other experimental boring was made upon the Luce ranch, and it showed:

Sandy loam	14 feet.
Quicksand, with water	50 feet.
Quicksand and clay	3 feet.
Quicksand	50 feet.
Grayish clay	283 feet.
Gravel stratum, yielding flowing water	4 feet.
Blue clay, varying to white, black, and yellow	240 feet.

A soft black clay, which yielded a "gas," was struck, and an attempt was made to ignite the gas by holding a match over the casing, but it did not burn. Unfortunately, the casing of this well was broken at the stratum of quicksand, and the well filled up.

On the ranch of J. Rickie, about 2 miles east of Sheridan, flowing water is said to have been obtained at a depth of 100 feet.

In the vicinity of Lincoln several borings have been made for water, and also to prospect for coal and pottery clay.

On the Rosenbaum ranch the formation penetrated is as follows:

Lava and cement	2 to	10 feet.
White, blue, yellow, and black clays		20 feet.
Alternate strata of white sand and clay		10 feet.
It is said that an analysis of this sand has shown it to be suitable for the manufacture of glass. The sand yielded water.		
Coal and clay mixed	2 to	10 feet.
Black clay, penetrated		150 feet.

At this ranch the water during the wet season stands at about 3 feet below the surface of the ground, but during the dry season it sinks to a depth of 12 or 14 feet.

In borings from half a mile to one mile east of the last described borings, and east of the county road, a series of borings showed:

Clay loam	1 foot.
Yellow and white clay	40 feet.
Black clay was penetrated	40 feet.

Water was struck at a depth of from 35 to 40 feet, which rose about 10 feet in the casing.

From 1 to 3 miles west of Lincoln a hardpan usually prevails to a depth of from 80 to 90 feet, beneath which strata of gravel and quicksand are penetrated some 3 to 5 feet; these yield plenty of water, which rises about 5 or 6 feet in the casing.

Dug wells around Lincoln are usually from 30 to 40 feet deep. In borings near the town, gravel and clay have frequently been penetrated for about 25 feet, followed by a dry black clay containing numerous "oyster and other shells." A gravelly ridge appears to extend through Lincoln nearly in a north and south direction. In this ridge water is scarce, the formation being clay and gravel, which overlie black mud containing shells; some gas has been noticed in the latter stratum. Black mud and shells are also said to have been observed beneath the ...easures near Lincoln.

Several experimental borings have been made by the Lincoln Pottery Company in their clay bank, which is situated at something less than a mile north of Lincoln. The clay bank is situated in a hill or ridge, the capping of which is a volcanic breccia some 15 feet in thickness. Beneath this breccia the formation is approximately as follows:

Sandy clay	8 feet.
White clay	15 feet.
White, sharp sand	2 feet.
White clay	3 feet.

At a depth of 28 feet, lignite similar to the Ione was struck, but in no great quantity. The clay is both blue plastic and white non-plastic. The following analyses were reported:

Blue Plastic Clay.	Per Cent.
Silica	44.82
Alumina	34.54
Combined water	8.37
Hygroscopic water	1.27
Carbonate of lime	3.00
Magnesia	.96
Soda	4.74
Sesquioxide of iron	1.86
Loss	.44
	100.00

White Non-Plastic Clay.	Per Cent.
Silica	41.80
Alumina	38.78
Combined water	6.00
Hygroscopic water	1.62
Carbonate of lime	2.64
Magnesia	1.02
Soda	3.46
Sesquioxide of iron	2.12
Loss	2.56
	100.00

About 2 miles west of Roseville, on the Kaseburg ranch, borings showed hardpan and gravel (the latter yielding water), 50 feet, and beneath those a light-colored sandstone, which was penetrated from 40 to 60 feet. The water rose but a few feet in most instances. About 1½ miles south of Roseville, on the Hannisch ranch, black sand and loam were passed through for 10 feet, and sand and hardpan, mostly sand, for 15 feet. At this depth there was plenty of water, but it did not rise.

About 3 miles southeast of Roseville, on the Blair placer mining property, the formation showed:

Auriferous cement gravel, water	18 feet.
White volcanic ash, and fragments of quartz and white sand	20 feet.
Coal	21 ins.
White volcanic ashes	15 feet.
Coal	6 ins.
Alternate strata of white ashes and gravel, with thin seams of coal, to a depth of	90 feet.

There were nine thin strata of coal altogether.

One hundred yards south from this boring, a similar formation was observed to a depth of 80 feet; the water rose to within 6 feet of the top of the casing, and gas bubbled through it. After an explosion of giant powder in the well, a flame, extending about 18 inches above the top of the casing, burned for about fifteen minutes. The water, although without much taste, possesses marked medicinal properties. At the bottom of the well a hard rock, "like granite," is said to have been struck.

Several years ago a well was bored at the cemetery, between Roseville and Rocklin, about 1 mile north of Roseville. Lava and cement were passed through to a depth of 50 feet, and beneath it a dark grayish sandstone was penetrated to a depth of 117 feet. At a depth of 90 feet "air or gas" was struck with an explosive noise. The "air or gas" is said to have blown with a strong current until the well caved in.

LINCOLN POTTERY.

This pottery was established in 1875, when one English down-draught kiln was put in operation. The present company, which was incorporated in 1886, is represented by Messrs. Gladding, McBean & Co., of San Francisco. Since their incorporation the business has increased until, when visited by the writer in December, 1891, the plant consisted of eighteen improved English down-draught kilns. This company manufactures sewer and chimney pipe, and all kinds of terra cotta goods; also fire-brick and drain tiling.

For the year ending Christmas, 1891, the product of these works was upwards of 700 carloads of manufactured goods. Within the last few years a great demand has arisen for "hollow arch tiling" to form fireproof floors between the "eyebeams" of buildings. This precaution is now insisted on by most architects in the construction of large city buildings. The demand for enameled terra cotta ware for "light shafts" in large buildings has also been met by this company, who have added the manufacture of this class of goods to their products. Previous to 1891 no enameled terra cotta goods were manufactured on this coast. The clay used by this company is obtained from the coal measures about 1 mile north of Lincoln, and a description of the clay bank and experimental borings there may be seen under the head of "Wells," etc., in this report.

PLUMAS COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

According to Professor Whitney's estimate, the catchment area of the Feather River is 3,393 square miles. Its three great branches, known as the North, Middle, and South Forks, run in their upper stretches through Plumas County, uniting in one stream lower down in Butte County. The North Fork traverses the northwest; the Middle Fork, starting from the southeast corner, passes through the middle; while the South Fork, taking its rise at the foot of Pilot Peak, on the border of Sierra County, follows near the southern boundary of the county. All of these streams have yielded largely in gold.

Through certain portions of the county that are traversed by heavy, low-grade quartz veins, there is a noticeable parallelism, following the general trend of these formations; their outcrop is bold, carrying occasional shoots of pay ore, and they have, no doubt, furnished largely the material for the white quartz gravel found in such abundance in the old channels of this and adjoining counties through which the Feather River passes. One of these prominent quartz veins can be seen near where Rush Creek enters the East Branch, and can be followed east across the river for several miles; another one passes through American Valley, and others cross the country between American and Indian Valleys, as also through the latter.

The mining interests that have been retrograding ever since the cessation of hydraulic mining seem to have passed their lowest ebb, and a little activity is once more evinced, some of the former hydraulic mines being drifted on where possible, and a few new quartz enterprises being inaugurated.

THE GRANITE BASIN MINES.

These mines at the time of the former report were straightening up and rebuilding after the previous hard winter. They are actively engaged at present in running their mills with paying results; some properties have changed hands, but no new enterprises have been inaugurated. The Homestake Mine is using a small prospecting mill, with a five-stamp Hammond battery, with 350-pound stamps, single cams, making one hundred and fifty drops a minute, 4-inch drop, run by a 24-foot overshot waterwheel, with a 2-foot breast.

THE EDMAN MINE.

Since the previous report of the State Mineralogist, the mine at Mumford's Hill has been partly retimbered, and the owners have carried an upraise through from the second crosscut. During this work Mr. Edman ascertained the presence of telluride ores in small quantities in his vein. The motive power in the mill has been increased by the erection of a

4-foot Pelton wheel with 115 feet of effective head. For the better working of the concentrates, a "spitzkasten" (pointed box) has been placed below the aprons, leading the pulp over blankets and through 90 feet of sluices with cross riffles. The owner has given very close observation to the working of the Huntington roller mill, which he employs for the reduction of his ores; he finds one objection to them in the manner that the rollers are hung and lubricated, occasioning the pumping of oil, which, if not closely watched, runs down into the pulp, and may be the cause of the complaint so frequently made, that "they do not save the gold."

The Diadem ledge of the Edman Mine can be traced along the flank of Spanish Peak range to near the head of Burton's Ravine, which has been worked as a placer and was extremely rich in quartz gold; thence to the Shenandoah Mine at the head of French Ravine, which was also extremely rich in quartz gold. From there it crosses the river, continues to, and flanks Mount Ben Lomond, near Lotts' Diggings.

THE M'GOWAN MINE

Is situated between the Edman and Shenandoah Mines, on the contact between the slate that flanks Spanish Peak range and the belt of diabase that is adjacent. This slate belt has a strike to the northwest of 25° to 40°, dipping to the northeast 60°. The lateral extent is about 1 mile. Next to the syenite of Spanish Peak the slates on the contact are somewhat changed; also the diabase belt, which is nearly 1 mile in width, has been greatly decomposed, being easily worked; it forms the bedrock in many of the rich surface claims that have been worked in this neighborhood. This belt runs to the Middle Fork and beyond in a southeasterly direction, also to the North Fork. On the east side of the diabase another slate belt, about one fourth of a mile wide, passes through the country, consisting of clay slate in the main, with some chloritic and talcose schists.

THE SHENANDOAH MINE,

At the head of French Ravine, has started more active operations. A ten-stamp mill has been erected about 1½ miles from the mine; the mill is run by water power. A road has been constructed from the mine to the mill, also a road out of the cañon to connect with the road to Spanish Ranch. The old tunnels have been cleaned out and a crew put to work to develop the property.

Since writing the above, the winter storms have uncovered a rich pocket below the tunnel on the hillside, the extent of which is now being proved.

Across the East Branch is a high hill of serpentine rock, called the Red Hill, and from there to the southeast the serpentine trends across the county into Sierra; near the East Branch it is over 4 miles wide. A large part of this formation in the neighborhood of Meadow Valley and Spanish Ranch is covered with alluvial and volcanic deposits.

In taking the trail from Spanish Ranch north to Kingsbury the road crosses where the serpentine intrudes wedge-shaped for 1 mile into the slate adjoining it on the east, and passes down the Kingsbury Ravine, which terminates in the slate. On this gulch is the Summit Drift Mine, with a tunnel running north 150 feet to where it strikes the gravel,

which is of a dark color, very tight; at a distance of 106 feet from the mouth pipe clay was encountered.

THE CENTENNIAL AND TOPAZ DRIFT MINE

Is also on this range, but more to the southeast. The company controls 204 acres. A drift has been run in on gravel 1,100 feet, at the end of which a 13-foot shaft was sunk to bedrock. A second tunnel, started 30 feet below, runs in bedrock a distance of 400 feet, at which point an upraise is being made to strike the bottom of the channel. From the bottom of the shaft below the upper tunnel drifts have been run both ways across the channel on the bedrock; on the one side the bedrock commenced to raise within 4 feet, on the other side the crosscut has penetrated 45 feet without reaching the rim rock. The cap of the channel consists of 10 feet of coarse, cemented sand, beneath which the gravel averages 10 feet, the lower 3 feet containing the pay. The gold is of the size of wheat grains and less. The channel, which is self-draining, has a grade of 1½ inches to the rod. The bottom gravel is pure quartz, the upper is quartz mixed with lava; the percentage of large bowlders is very small. About 6 miner's inches of water drains out of the tunnel, which is collected in a reservoir for prospecting the gravel. Sixteen-foot boxes are used on a 9-inch grade, with slat riffles. A water blast is used to ventilate the mine. The bedrock is clay slate, the channel coursing nearly with the slate. Six men are employed in the mine, at $50 a month and board, working two shifts.

PINE LEAF DRIFT CLAIM

Controls 40 acres. It adjoins the previous claim on the southwest, but has a channel that lies 150 feet higher. The ground was first prospected with a shaft, after which a tunnel was run in 700 feet. At 550 feet gravel was struck, which paid a little all through, but better near the rim. The channel has not been bottomed yet. The gravel is chiefly fine quartz. This company's tunnel was started at right angles with the direction of the previous company's tunnel, but turning later to the northwest, the gravel was first struck on the left side of the tunnel. The capping consists of 42 feet of pipe clay and 3 feet of sand. The gravel, though tight, is not cemented. The course of the tunnel for 623 feet is nearly north; then it turns to the northwest. At the end is an upraise of 14 feet, which connects with the shaft. The grade of the tunnel is 1½ inches in 12 feet; the bedrock is slate, and the back end of the tunnel runs with the strike of the slate.

A reservoir at the mouth of the tunnel furnishes water for washing the gravel. The boxes are set on a 9-inch pitch, and are supplied with slat riffles. At Kingsbury Ferry a bridge crosses the east branch of the North Fork, at an altitude of 2,830 feet. A short distance back from the bank of the river is the Hallsted hydraulic claim, no longer working. Following the trail down the right bank toward Rush Creek, some calcareous schist is crossed, having the same general course as the slates through this country. The same rock is met with again on the road from Spanish Ranch to Quincy, but the two occurrences, though nearly in line, do not appear to be continuous. At the mouth of Rush Creek, which is about 12 miles above Rich Bar (hence the name, Twelve-Mile Bar), is the

HALLSTED QUARTZ MINE.

This extremely large vein has a course 35° west of north, and dips northeast. The ledge, which will average 20 feet, is in places as wide as 75 feet. It is incased in slate, and presents a bold bluff on the river side, affording excellent facilities for tunneling. Several tunnels have been run in to the vein. One of these, 250 feet long, strikes the ledge at a depth of 300 feet, from whence drifts were run on the ledge east 125 feet and west between 30 and 40 feet.

The average of the quartz is low grade, containing quite an amount of fine-grained sulphurets, with occasional pockets of specimen quartz. A small four-stamp prospecting mill is on the property, run by water power, under 140 feet of pressure, with 40 miner's inches of water acting on an 8-foot Pelton wheel. Battery amalgamation, with a silvered apron 42 inches by 8 feet, and 12 feet of 20-inch sluices, are the methods applied for beneficiating the ore. On account of the breaking away of the dam of the Long Valley reservoir at the head of Rush Creek during the previous spring, the ditches, flumes, etc., of the company had been washed away and were being replaced under contract, previous to the company resuming operations.

Beyond this claim, immediately on the river, is the mining property of Messrs. Duncan & Patten, an extension of the Hallsted, which reaches across the river; the slate walls here are nearly perpendicular. The different rocks that are found at and in the river here, at the head of the Twelve-Mile Bar, are very interesting, comprising chrome iron, hornblende schist, clay schist, serpentine, diabase, lime, and quartz. A very fine specimen of tremolite was found here, which is now in the museum connected with the State Mining Bureau. In this claim the ledge, where it crosses the river, shows a breadth of 75 feet; it is heavily sulphuretted, galena, iron, and copper sulphurets predominating, with a rich sprinkling of free gold in places. These same parties own gravel ground on the bar. Like the previous company, these parties are repairing damages to ditches and flumes caused by the breaking of the aforesaid dam. Beyond these works is the Fred. Lewis claim, opened with a 60-foot tunnel. Two men are driving this tunnel ahead. On the opposite side of Rush Creek the granite approaches the river.

South of Meadow Valley an intrusion of syenitic granite breaks through the slates, which is overlaid partly by alluvial and volcanic matter; the slate formation continues to the Middle Fork, forming the bank of that branch for over 6 miles. The watershed between Meadow Valley and the Middle Fork has an altitude of 5,250 feet, being 1,640 feet above the level of the valley.

Near the junction of Onion Valley Creek with the Middle Fork, at Butte Bar, the river cut through a quartz ledge 5 feet thick, exposing it on the banks for a depth of several hundred feet; the ledge is known as the Nelson ledge, and yielded in former days, near the water's edge, rich specimen quartz. At present a company is working it under the name of the Butte Bar Mine. The title to the property is in dispute. It comprises two claims of 1,500 feet on each side of the river; although averaging 5 feet in width, the ledge spreads in places to over 12 feet. It has been opened by a tunnel starting on the ledge on the right bank and running in 90 feet. Next to the vein is a casing of chloritic slate thoroughly mineralized; the country rock is an arenaceous slate, with

a hard dike running along the foot wall. Next to the foot wall for a thickness of 2 feet, the ledge is heavily sulphuretted with iron, copper, and lead sulphides, and probably tellurides. In the horn-spoon test little or no gold is found, notwithstanding the test by fire reveals a value of several hundred dollars a ton. In early days a mill was, with great difficulty, placed on the banks of the river, which are abrupt and rocky, but it has disappeared long ago. For present purposes a mill site, a little back from the river, has been selected, to which water can be brought from Bear Creek. Eight men work here in two shifts.

In approaching Quincy from Spanish Ranch, the road follows on the right hand of Spanish Creek for quite a distance in front of the former hydraulic mines of the Plumas Mining and Water Company, now idle. Hungarian Hill, one of the oldest placer and hydraulic camps in the county, situated on a ridge that runs out from Claremont Hill to the northwest, has a drift mine in operation, worked by P. Hallsted, of Oroville, at an altitude of 4,900 feet. A tunnel running 22° east of north for a distance of 840 feet has cut through a channel filled with lava bowlders, and is being continued to strike a supposed back channel. The channel where crossed is 90 feet wide, running southeast and northwest. The water used for washing is taken from Slate Creek (near which the mine is situated), and caught in a reservoir; the gravel is run out of the tunnel immediately over the boxes. The gold found so far is fine, but most of it is rusty. Quicksilver is used in the boxes. No drifting has been done on the channel.

THE BONANZA PLACER AND DRIFT MINE.

Following the ridge to the foot of the main ascent on to Claremont Hill we find the Bonanza Placer and Drift Mine, which claims 70 acres. The two owners are driving a bedrock tunnel through the clay slate to tap a channel supposed to be running northwest and southeast. It is lava-capped, with 4 feet of pipe clay over 9 feet of gravel, and where it has been prospected by shafts down to the rim rock shows gold in the 3 feet of gravel next to the bedrock. The tunnel is in 350 feet, and it is thought that 100 feet farther will reach the channel. The slate bedrock crosses the channel, dipping at an angle of about 75°. Quite a heavy stream of water comes out of the breast of the tunnel. On the highest point of this ridge a heavy quartz vein crosses the divide, from the croppings of which, on a clear day, Mount Lassen, Mount Elwell, and Spanish Peak are in plain view.

This ridge, in conjunction with Claremont Hill, forms a divide between Spanish Creek and the Middle Fork of Feather River. On the south side of the ridge, parties are prospecting for a gravel channel that is thought to follow down on that side in the general direction of the Middle Fork. In ascending Mount Claremont, after crossing the lava flow above the last described mine, the clay and quartz schists appear on the surface with their old course, until a point is reached a little below the principal bluff of the main peak, where a part of the slate belt changes its course to nearly north and south. The bluff of the main peak has a lava capping and towers about 2,500 feet above American Valley.

Mill Creek heads at Claremont Peak, the east branch near the lowest peak facing American Valley, the west branch at the main peak. The

altitudes of the three peaks are 6,825 feet, 6,900 feet, and 6,975 feet. They form a triangle; from the middle, a bedrock ridge runs to Crescent Hill, southeast toward the Middle Fork of the Feather, which is covered with black lava. On the eastern side some of the blocks were furrowed, as if from glacial action, and blocks of lava were found with inclosures of quartz. On the side facing the Middle Fork of the Feather are the remains of the houses and tracks and tunnels erected by an English company, to work the Claremont channel, which is supposed to be a continuation of that worked in former years with such grand results on Hungarian Hill.

The presence of gold-bearing gravel on this peak has been demonstrated on the interior slopes of the southern rim, but nothing definite has been established. One tunnel has been driven about 1,000 feet and shafts sunk below it; another lower tunnel has penetrated over 200 feet.

North of American Valley, in the old Newtown Flat Mines, renewed activity has been displayed the past season. Messrs. Thomson & Thomas have driven a long bedrock cut to operate on a channel running through the divide, between Elizabethtown Ravine and Newtown Flat; during this work they have met with encouraging results, having found coarse channel gold, one of the pieces weighing $96, with several weighing over $20.

The bedrock cut, which is in Tate's Ravine, is 8 feet wide, and will tap the channel in 400 feet at right angles to its course; the latter part will have to be tunneled, and will attain a depth of about 60 feet below the surface and about 10 feet below the channel. The capping of the channel consists of 15 or 20 feet of soil, and from 4 to 15 feet of pipe clay, covering from 3 to 9 feet of free gravel; the bedrock is clay slate. Two qualities of gold are found—heavy wash channel gold and quartz gold, the latter supposed to come from a ledge that flanks the hillside and crosses the track of the cut. The company have leased the water privileges of the Plumas Mining and Water Company for their use, and during the last season have cleaned out and put in repair this large system, which comprises altogether about 35 miles of ditch. Six hundred and fifty feet of 36-inch flume, lined with blocks, will be used in washing the gravel; they will have the use of 500 inches of water under a pressure of 175 feet. At present seven men are employed. The flats below the present cut are gold-bearing, and would pay well if worked by hydraulic process. The conformation of the ground below offers good opportunity for putting in a restraining dam.

Cutting across the Blackhawk Ravine is a quartz ledge with several locations on it. The first, on the eastern end, is the Wormley claim, where a tunnel is being run into the hillside to intersect the vein. Adjoining, on the opposite side of Blackhawk Ravine, is

THE BUSHMAN & ORR MINE,

Where a tunnel has been run on the vein 350 feet, reaching about 75 feet under ground; no stoping had been done. A 4-foot Huntington rotary mill, with self-feeder and Dodge rock-breaker, to be run by a 14-foot overshot wheel, form the reduction plant. A new tunnel is to be started 20 feet lower.

A patent rock-crusher and amalgamator was seen here, the invention of Mr. Bushman, a short description of which is given as a mining curios-

ity. It consists of a solid wheel, about 4 to 6 inches wide, and from 2 to 3 feet in diameter, to which on the circumference four shoes of hard chilled iron are hinged in succession in such a manner that the uppermost one lies snugly on the face of the wheel, with the hinged edge to the direction of the motion; while the opposite one is dragging over the die in the bottom. The wheel is hung in a cast-iron, closed box, a little wider than the wheel, having a rectangular iron die, about 3 inches thick, fitted on the bottom, extending under and in front of the wheel, which hangs nearer to the back of the box. On the sides of the box in front screens are placed, while above is a feed-hopper; at the back is a plug to admit water. As the wheel revolves toward the feed, the hinged shoes fly out by centrifugal force and strike on the quartz lying on the die. After the blow is delivered, the shoe drags some of the quartz under with it until the hinged end commences to ascend. In the model at the mine the shoe drags over the die a distance of 4 feet.

A part of the ravine at the mine was being worked as a placer by Mr. Bushman.

THE THOMSON & KELLOGG MINE.

To the west of this claim and adjoining it is the Thomson & Kellogg Mine, situated on Eliza's Fork of Little Blackhawk. Three tunnels are run in the sidehill from the ravine to cut the ledge; the lowest is 150 feet long, but has not yet reached the vein; the second is about 60 feet long, and the upper one, which is on the vein, has a shaft sunk below it to a depth of 100 feet, which is in good ore at the bottom.

The quartz in this claim carries a larger percentage of sulphurets and black oxide of manganese, also larger cubes of iron pyrites, than the adjoining claim below. The sulphurets assay up to a very profitable figure.

The Eliza's Fork Ravine has furnished exceedingly rich placers, from where this vein crossed, down to its mouth, pieces of quartz gold several hundred dollars in weight having been found. Little Blackhawk Ravine, below where this ledge crosses, has likewise been very productive. As the owners of this mine have large and varied agricultural and mercantile interests, which require all their personal attention, this mine has not received the development its apparent merits deserve.

THE GOLDEN GATE QUARTZ MINE

Is an old claim that has started into renewed activity the past season with apparent success; it is in the Butterfly Mining District. The vein lies very flat, at an angle of about 20°, and varies in width from 14 to 15 feet; the rock shows free gold, and is said to pay about $20 per ton. A five-stamp steam mill has been moved to within one half mile of the property, the necessary water being obtained near the head of Little Butterfly Creek. The walls of the vein are slate. The vein dips with the slope of the hill, a large area of it being exposed.

A revival of mining interests is to be noted in the Crescent Mills neighborhood, in Indian Valley. The Green Mountain Mine, which was shut down by attachments several years ago, has so far arranged matters as to be able to appear on the list of bullion producers for Plumas County once more. A crew of forty men has been set to work, the lower tunnels have been cleared and retimbered where necessary,

and one half of the fine sixty-stamp mill put to crushing quartz. The mine and mill have been thoroughly reported on in previous reports of the State Mineralogist.

THE CRESCENT MINE.

During the past season the management have continued their working shaft down 200 feet farther, and are now preparing to drift off to the ledge.

Mill Creek, that comes down from Claremont Peak into American Valley, has three companies at work near the junction of the west and middle branch. The gold is coarse and the gravel free.

Following the road from American Valley up the Middle Fork of the Feather River, the tunnel of the Consignee Mine is crossed, now in over 2,000 feet and still pushing ahead for a channel supposed to run in front of them.

THE PLUMAS EUREKA.

Around Johnstown the Plumas Eureka still maintains her position as preëminently the foremost mine in Plumas County. During the past year some changes in the management have occurred, but no retrograding in the active working of the mine is discernible.

THE LITTLE JAMIESON

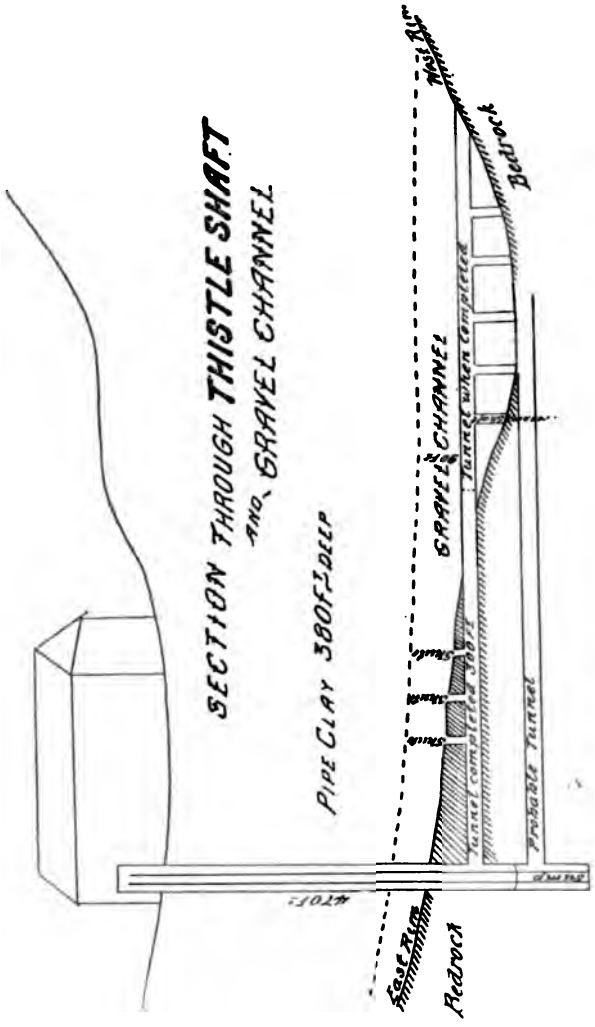
Is actively driving her tunnel ahead and otherwise preparing to open the mine in shape; this is a very promising mine.

In passing from American Valley over into the most southerly part of the county, the road ascends Thompson's grade, and beyond that to Nelson Point. To the northeast from the store at Nelson Point are high bluffs of lava extending through the divide to the other side near the sawmill, before reaching which some granite bowlders are encountered, although no granite is in place here. The road winds along over steep grades, ever ascending, flanking the ravines of Onion Valley Creek. After passing Onion Valley, it enters a serpentine belt, in which it continues until on the south side of Pilot Peak, where basalt and lava overlie the formation. All this section of country, and from here on to La Porte, has proved one of the richest old river channel grounds in the State. It has been worked in different parts along the La Porte road, and is known as the Gibsonville channel. The altitude of the summit on the road passed over is 6,430 feet.

The Gibsonville channel is supposed to come down southwest, nearly parallel with the general course of the present Slate Creek, along the east branch course of Rabbit Creek; thence crossing Rabbit Creek and Slate Creek in the neighborhood of Smith's Diggings, unites with the Portwine channel about Poverty Hill. The principal operations on this channel at present are the Thistle shaft and the Claybank tunnel running under Bald Mountain.

THE FEATHER FORK MINING COMPANY.

Their ground, on the Gibsonville channel, has been crossed by a tunnel to date, a distance of 625 feet, but only 100 feet is truly channel. The bedrock is slate and strikes across the channel.



The property is held by a Scotch company, who have bought up about 4 miles of the channel; it is better known as Thé Thistle Shaft Company. The channel has a capping of 380 feet of pipe clay, overlying 90 feet of sand and gravel. Its general course is north 26° east. The top of the deposit has an altitude of 6,000 feet above sea-level; the elevation of the underlying blue slate is 5,403 feet. The present works are carried on through a three-compartment shaft 475 feet deep, thoroughly timbered and planked throughout, costing $30 a foot to sink.

From the shaft a bedrock tunnel runs in 300 feet to the channel, which was struck on the rim rock; the tunnel is to be continued through the gravel to the west rim. A prospect hole sunk from the bottom of the tunnel 11 feet was drifted a short distance on the bedrock, but was discontinued on account of water. The mine is ventilated by steam suction through a 7-inch pipe. The water pumped from the mine fur-

nishes the water for washing the gravel, which is not cemented. The cobbles and bowlders constitute one half the gravel. A carload as filled in the mine weighs 3,000 pounds. The gold extracted is worth $19 per ounce. Wood costs delivered at the mine $3 per cord. The motive power used is a single-acting, link-motion engine. Twenty-five men are employed about the works; four men are on a shift underground, working eight hours, for which they receive $3 per day.

THE GOLD MOUNTAIN CONSOLIDATED GOLD MINING COMPANY

Is situated near the town of La Porte. Their tunnel is running in the bedrock to strike the Gibsonville channel, under Bald Mountain, just north of town, and has attained a length of 4,545 feet; from whence an upraise of 36 feet ascends to a drift run toward the west 375 feet; this is followed by another 36-foot upraise, from which there is a drift of 650 feet in the first direction, but bearing slightly more to the west. The country rock is slate. So far no pay gravel has been tapped. A bore hole put down on line of tunnel shows 307 feet of lava and 127 feet of gravel. The opinion is held by experienced miners that the channel runs on the back of Bald Mountain instead of in front of or underneath the hill. The company will continue to drift ahead to determine the presence and direction of the channel. This tunnel is known as the Claybank tunnel.

Where Slate Creek forms the boundary line between Plumas and Sierra Counties, a part of the cañon has been located as a tailings claim. For years, as long as the hydraulic mines were permitted to work, a large number of them emptied their tailings into Slate Creek Cañon, until the accumulation has reached a depth of 60 feet in places, with a width varying from 160 to 1,200 feet. From the fact of the original gravel carrying considerable pipe clay, which readily picks up gold, and carries it a long distance, these tailings should have become quite valuable, and are so considered.

THE ALTURAS,

Which is the name given to the tailings claim, holds 5½ miles of the bed of Slate Creek, with the margin of high-water mark for side lines. It is about 2 miles west of La Porte, between it and St. Louis. The tailings average 20 feet in depth. The high water every season is made use of in concentrating down the material, for which purpose, where available, bedrock cuts are run through projecting points. In working the claim at present pits are dug through the debris to the bedrock, and the bottom gravel shoveled into boxes that are given a 6-inch grade in 12 feet; these boxes are supplied with Hungarian and slat riffles. The gold obtained sells for $17 60 per ounce. The money value per cubic yard could not be ascertained, but from the fact that expensive lawsuits are engaged in to decide the title to these claims, it may be assumed that the ground is very valuable.

In the opinion of experienced miners, who have been familiar with the cañon for a great number of years, there must be millions in store awaiting the thorough working of the Slate Creek tailings. All of the country around the headwaters of South Fork of Feather River, Slate and Cañon Creeks is traversed by channels which have yielded large

results to the hydraulic and drift miners, much still remaining to be reached through drifting under the lava cap that covers so much of this country.

The amount of white quartz gravel found in the old diggings of this section, as also at Cherokee Flat, in Butte County. is astonishing. The greater part of this quartz contains but very little gold, although the amount of gold found with it has been considerable. Perhaps at some future time, when the reduction of quartz can be accomplished in large quantities at a low cost, these masses of quartz bowlders already broken to hand, as seen in the worked-out channel around La Porte, may be made the source of a good revenue.

The question might be asked, How, so near to the summit of the Sierra Nevada Mountains, where the channels are wide, but comparatively shallow, could there be such an accumulation of quartz in the river beds to the exclusion largely of other rocks? The evidences of glacial action are insufficient by themselves to account for this, more especially as modern investigations have shown the erosive actions of glaciers to be far less than has been hitherto attributed to them. The following observation made in Plumas County might account in part for the material thus accumulated: Through Plumas and Sierra, and partly into Butte, running with the general range of the slates, especially the clay slates having the same dip, are large, continuous bodies of white quartz, containing little or no gold and but few iron sulphurets. Apart from these are other quartz vein systems, especially contact veins, carrying sulphides of the different metals, and in places richly sprinkled with gold. Observations made at places where inroads have been cut along the flank of the slate in the general direction of its course in the cañons of streams, indicate that a gradual crumpling, crushing, and final sliding motion is started in the portion above the cut, and where the area affected is large enough, the force and pressure become sufficient to break away large parts of these included, rib-like quartz veins. The waters of the streams in eroding the cañons start the same movement on a much more extended scale. The clay slate, as it becomes subjected to the action of the water, would be rapidly and thoroughly disintegrated and carried to the lower reaches of the stream; the harder quartz, on which the action of the water would be very slow, and not nearly as complete, remaining to gradually fill up the channel bed.

SACRAMENTO COUNTY.

By W. L. Watts, Assistant in the Field.

The most important mineralogical item that has come to the knowledge of the State Mining Bureau from Sacramento County during 1891–92, is the corroboration of the statements made in the last report with regard to the immense subterranean water supply which exists at no great depth beneath the city of Sacramento. It is true the pumping experiments were, in one instance, hindered by gas, but this could be obviated by casing off the gas-yielding stratum, or by allowing the water to accumulate in a shaft of large diameter sunk to the level of the water plane.

The first gas well, although not a decided success, has demonstrated, first, that a good flow of water can be obtained in Sacramento by boring a few hundred feet; and second, that a large amount of gas is stored up in strata underlying the city.

The work in which the State and the Folsom Water Power Company are engaged at Folsom appears to be actively progressing, and must eventually be an important factor in the welfare of the county.

WATER.

In 1891–92 a 6-inch well was bored to the depth of 160 feet at Oak Park, in the southeastern outskirts of Sacramento City, the object being to test the available water supply at that depth. The formation penetrated is as follows:

Soil	2 feet.
Hardpan	2 feet.
Sand	8 feet.
Grayish clay	133 feet.
Sand	15 feet.

The water rose to within 12 feet of the surface. A centrifugal pump, pumping 50,000 gallons of water an hour, worked continuously for ten hours, and lowered the water about 16 feet. The first day probably one cubic yard of sand came up with the water.

The water was analyzed by Prof. W. B. Rising, of the University of California, and found to be of excellent quality; it showed:

	Grains to Gallon.	Parts in 1,000,000.
Residue before ignition	9.88	.....
Residue after ignition	7.48	.....
Chlorine	.55	.....
Free ammonia	.....	.02
Albuminoid ammonia	.....	.05

"The above tests indicate a water well adapted for domestic use."

A second well was bored on the M Street road, about 2,000 feet east from the city limits, and about half a mile north from the first well. The formation is similar, except that the water-bearing sands were coarser and more compact. This is a 12-inch well, and was bored to a depth of 160 feet. From this well 50,000 gallons an hour were pumped; a charge of dynamite was then exploded in the well, after which the pumps were found to work in an unsatisfactory manner. It was first supposed that a leak in the water pipe admitted air and interfered with the pumping; after investigation it was said to be gas which interfered with the working of the pump. It is probable that this was carbonic dioxide, which Dr. Southworth, of Sacramento, informed the writer was found in the upper strata of the gas well bored by his company.

Carbonic acid gas was also observed by the writer in a shallow well at Carbondale.

COAL.

Mr. M. D. Gill, who resides about 4½ miles northwest of Carbondale, informed the writer that coal had been penetrated to a thickness of about 9 feet in several wells on his ranch. He also sunk a shaft for water 85 feet deep. This shaft penetrated the coal, the head wall of which was soft black clay, and the foot wall hard black clay. This well is frequently pumped dry in summer with a 12-foot windmill pump.

The formation penetrated is:

Reddish sandy loam	3 feet.
Red clay	3 feet.
Reddish gray sand	16 feet.
Hard, whitish sand rock	13 feet.
Grayish sand rock, softer	38 feet.
Soft black clay	5 feet.
Coal	9 feet.
Hard, blackish clay.	

At Sacramento, several improvements have been made in the construction of the furnaces of those using the Ione coal, which have resulted in better satisfaction with it as a fuel.

At the Phœnix mill, air chambers, terminating in grated openings behind the fire-bridge, have been built in the sides of the fire-box, the outer openings being on both sides of the fire doors. This allows a fresh supply of air to come in contact with the heated gases arising from the coal, which, by this means, are ignited in the air space beneath the boilers instead of escaping up the smoke stack. Before the use of these air chambers dense, black smoke issued from the smoke-stack; if these chambers are shut immediately after firing the smoke issues forth as before, but when they are open only a light vapor is seen. It is the opinion of the engineer that the air chambers save about 5 per cent of the fuel.

At the Capital Packing Company an extra supply of air is admitted into the fire-box through flues in the sides of the furnace, the mouths of the flues being level with the furnace doors. More air is also admitted through flues in the fire-bridge, which also have openings in the sides of the furnace. This company use shaking bars, which prove a great saving of labor when Ione coal is used. These shaking bars prevent clinker, and the ashes are shaken from them by working a lever at the side of the furnace.

THE FOLSOM WATER POWER COMPANY.

During 1891-92 the work on which this company and the State are engaged at Folsom was actively prosecuted. The dam head-gates and retaining walls of the first section of the canal on the south side of the river were completed as far as the State power-house; and at the time of this writing the State power-house was practically finished, and its machinery nearly all in place. Work has also progressed on the outer retaining wall below the State power-house, and only about 100 feet more is required to complete it.

SAN BERNARDINO COUNTY.

By W. H. STORMS, Assistant in the Field.

No portion of California has more diversified mineral wealth than the county of San Bernardino. Although its area is comprised largely of rugged mountains and desert waste, yet this county is a producer of gold, silver, copper, lead, and tin, and contains mines of zinc, iron, and manganese, besides deposits of borax, salt, soda, baryta, gypsum, sulphur, onyx, marble, asbestos, and structural material, granite, and sandstone of great beauty and value. Within its borders are found a wide range of geological formations from Paleozoic (if not Archæan) to Tertiary, and a great variety of rocks of igneous origin.

The mines are scattered all over its thousands of square miles of territory, and have already added millions of dollars to the wealth of the State and the world. Many of its mines are of phenomenal richness, and were it not for the expense and extreme difficulty attending transportation in the desert, San Bernardino County would undoubtedly take first place in adding to the mineral wealth of California. The largest and most productive section in the county at present is

THE CALICO MINING DISTRICT.

No region affords better opportunities for the study of a certain class of ore deposits occurring in eruptive and fragmental rocks than may be found in the Calico District. The mines, condemned at first, came quickly to the front nevertheless, and have for the past twelve years been steady producers of silver bullion. The district is situated 6 miles north of the Atlantic and Pacific Railroad, the nearest station being Daggett.

GENERAL GEOLOGY OF THE REGION.

The geology of the Calico Mountains at first sight looks simple enough, but a more thorough investigation quickly convinced me that there were structural problems to be studied of more than passing importance, as they seemed to have a bearing upon the extent of the ore deposits. The most complex region is that immediately about the town of Calico, in the vicinity of the mines. The balance of the mountain area is more simple.

In a general way the Calico uplift consists of a core of massive rhyolite, overlying which are heavy deposits of light-colored breccia and tufa. Along the flanks of the range, and in some places extending well up into the mountains, are accumulations of undoubted sedimentary origin, sandstone, sandy shales, and argillaceous rocks, which, with some local exceptions, dip away from the central mass on all sides toward the desert plain. While in the district I made some notes on the general geological features, but not having sufficient time at my

disposal to complete these investigations, I have determined not to present my views until I have had an opportunity to investigate the region more carefully.

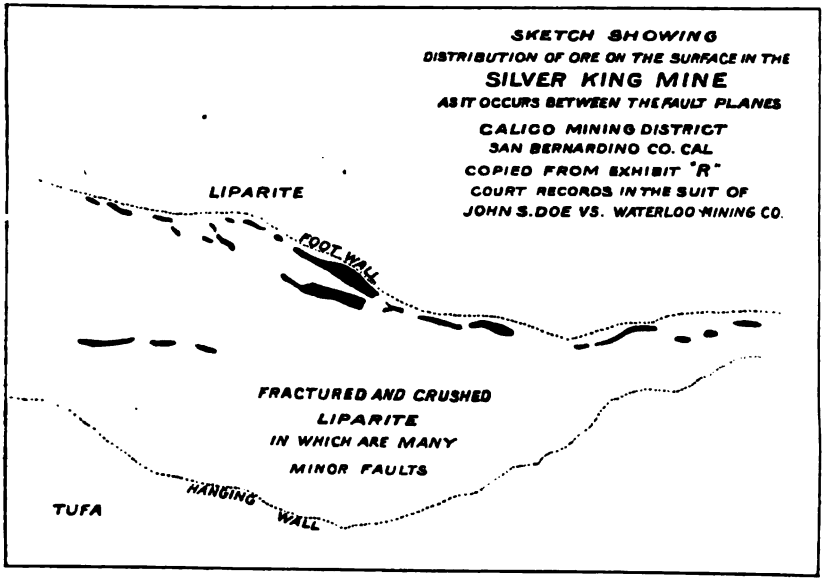
Subsequent to the uplift of these mountains, erosion has carved deep cañons and removed great mountain masses. The central area is now entirely denuded, whereas it was at one time covered with from 100 to 200 feet of tufa and upward of 1,000 feet of sedimentary strata. Not only have these more recent accumulations been removed, but a large amount of the hard, dense liparite has also been disintegrated and carried away by the violent storms which are characteristic of the desert. Faults are very numerous throughout that portion of the mountains lying along the south side of the range. They extend for at least 10 miles in an easterly and westerly direction. The mines occur along this faulted zone.

The rocks of the region are a violet to brown rhyolite, often porphyritic; green, yellow, and white tufa; yellowish and greenish breccia; a greenish gray, fine-grained rock, which has been called hornblende andesite by Mr. Lindgren, and a yellowish or buff to light gray felsitic rock, which may be either rhyolite or an older felsite. It is extremely difficult to distinguish between these rocks, even with the aid of thin sections under the microscope. I think, however, upon structural grounds, that I may call the rock felsite. As this is one of the important questions upon which I have not thoroughly satisfied myself, it will be left until such time as I have opportunity to make the necessary investigation.

THE ORE DEPOSITS.

The formation of the ore deposits in the Calico District has been a subject of much discussion, and the question has received the closest study and thorough investigation. In my opinion, the ore deposits were formed through the agency of percolating waters carrying mineral solutions, which deposited their contents along fault planes and in certain zones of the country rock, where its brecciated and crushed state offered superior conditions for the deposit of the silver ores and the accompanying baryta. That all of these ore deposits have a common genesis I do not doubt, whether they occur in the liparite, in the tufa, or in the "mud" overhanging country rock, as is the case at the Bismarck, Humbug, Waterloo, and some other mines. The form of the deposits differ somewhat, it is true, for we find the reticulated veins in the King Mine; the segregated deposits in the Odessa and Waterloo; the fissures in the Langtry, in West Calico, and the impregnated deposit in the Humbug. However, all the deposits of the district, of whatever form, I believe are due to a common cause, having been deposited in their various forms from mineral-bearing solutions which derived their contents from the neighboring eruptive rocks (the liparites and tufas), part of the material doubtless arising from great depth, and a portion coming from the adjacent inclosing rocks by what is known as lateral secretion. It is almost an impossibility to find in the Calico region a piece of rock that does not contain more or less silver, from a fraction of an ounce per ton upward.

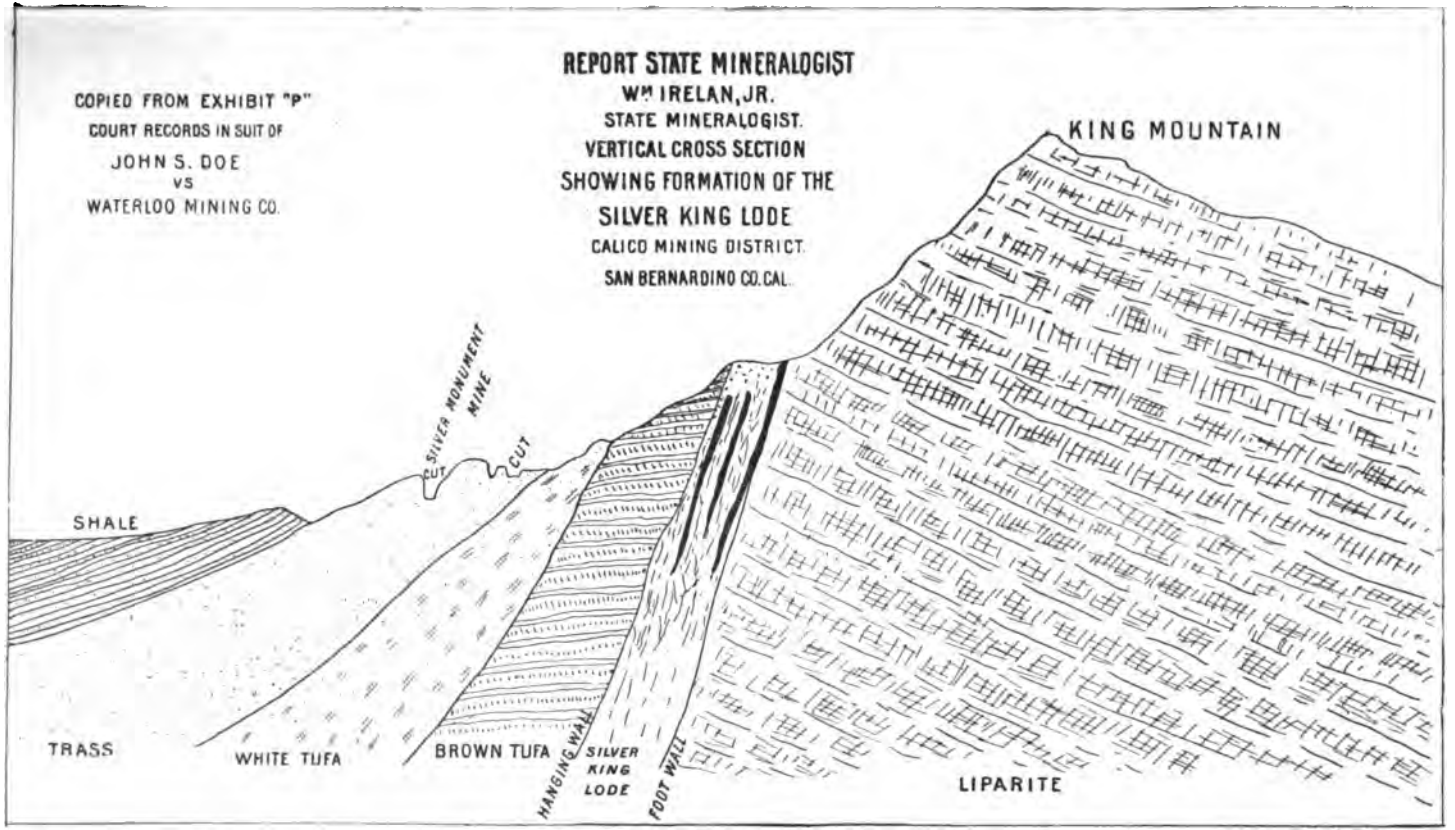
The phenomena of ore deposition was very thoroughly investigated by Messrs. Louis Janin, E.M., John Hays Hammond, E.M., Ross E. Browne, E.M., and Wm. Irelan, Jr., State Mineralogist, at the time of

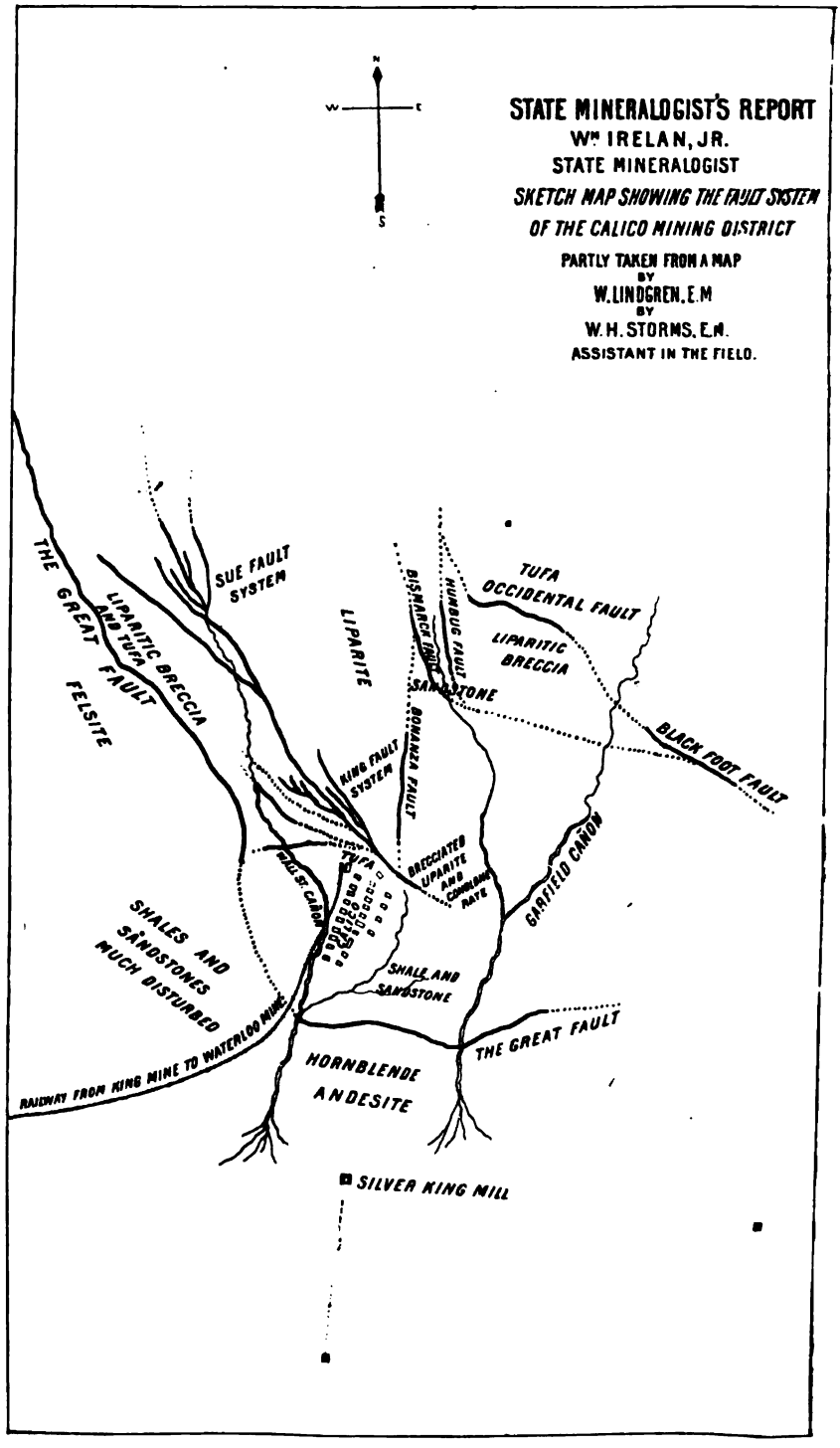


the lawsuit of John S. Doe vs. Waterloo Mining Company. These gentlemen all agreed upon the origin of the ore deposits, and their opinions coincide with my own and are in accordance with the ideas expressed above. The wide difference in the size and form of the many ore bodies does not in any manner conflict with the theory that in each instance the primary cause of the deposit was a fracturing and crushing of the rock masses and the subsequent infiltration of mineral solutions, which precipitated their contents in the zones and crevices thus prepared for their reception.

In the Silver King Mine occurs a perfect network of veins, concerning which Mr. Hammond testified: "At the time of the uplifting of the liparite, or at some subsequent time, a fault occurred, which separated a wedge-like mass of liparite from the main mountain mass, and this fault plane was generally conceded to be what might be termed the foot wall of the mineral belt, or zone, or lode. Contemporaneously with this faulting a second fault occurred, which separated the overlying brown tufa from the liparite, which fissure forms the overhanging wall of the mineral deposits of the Silver King Mine. At the same time cross fissures were formed in the liparite mass between the two main fissures. Thus there was a main fissure or plane of contact between the brown tufa and the liparite, and a similar fault plane between the segment of liparite broken off and the main mass of the mountain. Between these two main fissures, and throughout the whole mass of this segment of liparite were innumerable fissures, some similar and equal in size to the main fissures, and others forming a finer system of fissures and cracks, extending through the rocks in all directions, leaving it in a broken and disintegrated, and in many places an almost pulverized condition. Although these finer fissures generally had a parallelism with the two main fissures bounding this segment of rock, yet, in many places, these finer seams or fissures run in every direction through the rock, forming a network, or reticulated mass. The mineral-bearing

CROSS SECTIONS OF
SILVER KING MINE
TAKEN FROM COURT RECORDS IN SUIT OF
JOHN S. DOE VS. WATERLOO MINING CO.
NORTH
HANGING WALL COUNTRY
BARREN MUD
BARREN TUFA
FOOT WALL COUNTRY
BARREN LIPARITE
KING TUNNEL
THE LODE
4th LEVEL
5th LEVEL
6th LEVEL
7th LEVEL
8th LEVEL
9th LEVEL
10th LEVEL
Foot Wall
KING
NORTH


COPIED FROM EXHIBIT "P"
COURT RECORDS IN SUIT OF
JOHN S. DOE
VS
WATERLOO MINING CO.
REPORT STATE MINERALOGIST
WM IRELAN, JR.
STATE MINERALOGIST.
VERTICAL CROSS SECTION
SHOWING FORMATION OF THE
SILVER KING LODE
CALICO MINING DISTRICT.
SAN BERNARDINO CO. CAL.
KING MOUNTAIN
SILVER MONUMENT MINE
CUT
CUT
SHALE
TRASS
WHITE TUFA
BROWN TUFA
HANGING WALL
SILVER KING LODE
FOOT WALL
LIPARITE


STATE MINERALOGIST'S REPORT
Wm IRELAN, JR.
STATE MINERALOGIST
SKETCH MAP SHOWING THE FAULT SYSTEM
OF THE CALICO MINING DISTRICT
PARTLY TAKEN FROM A MAP
BY
W. LINDGREN, E.M
BY
W. H. STORMS, E.M.
ASSISTANT IN THE FIELD.
N
W
E
S
THE GREAT FAULT
FELSITE
LIPARITIC BRECCIA AND TUFA
SUE FAULT SYSTEM
LIPARITE
BISMARCK FAULT
HUMBUG FAULT
SANDSTONE
TUFA
OCCIDENTAL FAULT
LIPARITIC BRECCIA
BLACK FOOT FAULT
KING FAULT SYSTEM
ROMANCE FAULT
BRECCIATED LIPARITE AND CONGLOMERATE
GARFIELD CAÑON
SHALES AND SANDSTONES MUCH DISTURBED
SHALE AND SANDSTONE
THE GREAT FAULT
HORNBLENDE ANDESITE
RAILWAY FROM KING MINE TO WATERLOO MINE
SILVER KING MILL

waters have deposited throughout this mass, from wall to wall, the minerals now found within this zone in the form of baryta, carrying silver. The finding of baryta in the shattered planes of the liparite, which is entirely foreign to the rock itself, is sufficient evidence that a crack or space must have existed prior to its deposition, from the solutions which penetrated this broken zone of a once massive rock formation."

The Odessa Mine offers good illustrations of impregnated masses, as does also the Waterloo. In each of these mines, as in many others, the ore bodies are found in bunches or pockets, varying from little deposits of nominal value to great ore chambers containing thousands of tons of pay rock. In these cases, as at the King Mine, a system of faulting planes marks the general strike of a mineral-bearing zone or lode, but the great rock masses of tufa, in which these ore bodies occur (and also of sandstone in the Waterloo), are quite loose and porous in texture, and undoubtedly the ore bodies in these mines resulted partially, at least, from the impregnation of the rock with the mineral solutions which found an easy passage along the fault planes that had cut the rocks in every direction.

In the Waterloo Mine one of the fault planes exhibited a regularity seldom seen in any mine. It coursed through the light-colored, soft tufa in an easterly and westerly direction, was perfectly true, and as smooth as any hard-finished wall could be made by the most skillful artisan. The fracture was of knife-blade thinness, and its sides were coated with dark red iron oxide. It dipped to the southward at an angle of about 40°. At one time it was considered to be the hanging wall of the lode, but a miner broke through the wall to cut a hitch for a timber and it was found that the overlying rock beyond the slip was ore-bearing also. Stopes in this mine were frequently over ten sets in width, or over 60 feet. At the eastern end of the claim some extremely rich ore was mined from a belt of jasper, a metamorphosed clay shale, which by heat and pressure had become an intensely hard, fine-grained, flinty rock, yet some of this jasper contained over 1,000 ounces of silver per ton.

In West Calico, 2 miles west of the Waterloo, is the Langtry group of claims. The principal development is on the west end of the Langtry Mine. The Langtry may be called the anomaly of the camp, as it is a fissure vein pure and simple, or, more strictly speaking, two fissures.

The strike of these two fissures, which are 60 feet apart, is nearly parallel, but they will undoubtedly meet in depth. That on the south side dips northerly, while the other pitches toward the south slightly. Both stand at a high angle, and it is doubtful if they will converge inside of 250 feet from the surface. The veins are composed principally of a coarsely crystallized baryta with quartz, containing brown iron oxides, lead carbonate, ochre, manganese oxide, and chloride of silver. The average value of the ore was about 22 ounces per ton. The veins vary from a thin seam to over 10 feet in width on the north vein, having an average width of 3 or 4 feet. These veins occur in the "outside" or "mud" country, which lies along the flank of the southern slope of the Calico Mountains. The mud shales and argillaceous sandstones here lie nearly horizontal, the veins cutting them at an angle closely approximating 90°.

SUSPENDED MINING OPERATIONS.

The low price of silver during the past two years has resulted disastrously to the mining industry in Calico District. The great Waterloo, for many years the largest producer, and employing not less than 150 men in mines and mills, was closed down, as it seemed foolhardy to exhaust the great ore bodies when the profit derived from the extraction and milling of the ores was merely nominal. For years these mines had kept the sixty-stamp Boss process mill and the fifteen-stamp pan mill at Daggett busy night and day, but in the spring of 1892 the stamps were hung up and the mines closed, awaiting better prices for silver.

The Silver King Mining Company (limited), of London, has continued to operate, dropping twenty to thirty stamps night and day, under the superintendency of William S. Edwards. The King Company owns or controls three important groups of mines in this district, viz.: the Odessa, the Oriental, and the Occidental. The Odessa made a record during the early history of the camp by the production of ores of high grade. The policy which was pursued in those "palmy days"—to gouge out the rich ore whenever it could be found, without regard to future condition of the mine—left most of the mines in very bad shape. The Odessa is now recovering under the new management, and the property is being systematically opened, and it is thought all the ore can be extracted. In this mine are stopes from which thousands of tons of ore have been mined, and there is not a stick of timber of any kind in them.

These old stopes are being cleaned out, new levels opened, and good results are expected in the future. What applies to the Odessa in this respect is true to a great extent of every other large mine in Calico. They were all worked in a hand-to-mouth sort of fashion, and although many of these mines paid handsome dividends, little of the money was ever put back in anything like permanent improvement. All seemed to share a common opinion—that the deposits were superficial, and would not go down, and as a result no one felt like laying out money in an extravagant and unwarranted manner. But the mines have gone down, and the men in charge of the mines to-day can see the result of the mistaken economy of the early operators, and see in Calico an era of recovery of low-grade ore bodies and development work which is calculated to give the mines greater apparent permanency than ever heretofore. December 1, 1891, the King mill was enlarged by the addition of ten stamps, making thirty in all. The Boss process of continuous amalgamation was also adopted.

CHLORIDING THE MINES.

A system of leasing portions of mining claims, called "chloriding" in Calico, was introduced in the early days, and is still in vogue. Many poor men have made moderate fortunes in the district, and in days gone by all did well. The mines are leased on a royalty of one fourth to one sixth of the ore to the claim owner, according to its value, the owner receiving more as the grade is higher. Chloriders were at work on the Loo, Little Waterman, Humbug, Bismarck, Blackfoot, and other mines, during the past year. The ore obtained in this manner is usually sacked and shipped to a custom mill, where it is crushed, the charges ranging from

$9 to $12, according to the character of the ore, some (the more brittle) milling much faster than others.

THE WATERLOO MINE.

The Waterloo property consists of four claims. The principal workings are in the Waterloo Mine, where large stopes have been extracted, though considerable amounts of ore still remain in sight. An idea of the extent of some of these Calico mines may be gained from the fact that the great ore body of the Waterloo is 1,100 feet in length, and is known to extend from the surface down to the 525-foot level. At the east end the ore-bearing zone is from 4 to 7 feet in width, widening downward. Going westward it increases in width until it is 60 to 70 feet wide. This mine, like those immediately about Calico, was worked for rich pockets, and, as a natural consequence, the mine was left in bad condition. Jos. D. Kerbaugh, the last Superintendent of the mine, had inaugurated a systematic method of extracting ore and recovered much lost ground. The ore is usually low grade, and this, in connection with the low price of silver, has resulted in the closing up of the mines. A narrow gauge railroad has been in use for several years to transport the ore from the Waterloo group and the King and Red Jacket Mines, owned by the same company, to their mills at Daggett, timber and supplies being brought to the mines on the return trips. The transportation of ore, I was informed, cost 12 cents per ton. The railroad is about 7 miles in length, and runs on a pretty steep grade.

THE BORAX MINE.

In the upturned sedimentary beds which flank the Calico Hills, dipping outward toward the desert plain on all sides of the uplift, except where purely local disturbances have caused a reverse condition, are bedded deposits of calcium borate and gypsum (calcium sulphate). Five miles east of the town of Calico is the largest known deposit of calcium borate in the district. The bed, or vein, as it is called, was discovered some years since, and finally passed into the hands of the present owners, the Pacific Coast Borax Company, whose extensive works are located at Alameda, near San Francisco.

GEOLOGY OF THE BORAX DISTRICT.

The borax mine occurs as a bedded vein in the sedimentary strata, which in Tertiary times were uplifted in the Calico range. The sediments are composed of sandstones, sandy clays, and clayey sands, comprising a succession of heavy-bedded, deep-water deposits, and shallow-water, thin-bedded shales and sands. These variations in the character of the strata are numerous, and mark the many oscillations of the region, whose rising or sinking either submerged the strata beneath the waters of a deep lake, or lifted them until the water flowed over the mud flats only in thin sheets, which, exposed to the rays of the sun, sometimes evaporated entirely. Climatic conditions doubtless also were an important factor in the history of these strata, which are upwards of 1,000 feet in thickness.

Underlying the sediments are the tufas of the Calico region, and

beneath them is found the mass of liparite which underlies this entire region. The sediments are not materially different from those in the immediate vicinity of Calico. The rocks have not suffered in the region about the borax deposit the slightest metamorphism.

The borax vein is traceable for several thousand feet, striking along the western and northern side of the largest sedimentary hill in the range, and finally passing down a cañon to the eastward, where it becomes a well-defined vein. Toward the western end the borate of lime appears to be much mixed with the sandy sediments, gypsum, and clays, giving the appearance of having been formed near the shore line of the basin in which this great mass of material has been left as a residuary deposit, due to the evaporation of the water containing the calcium borate.

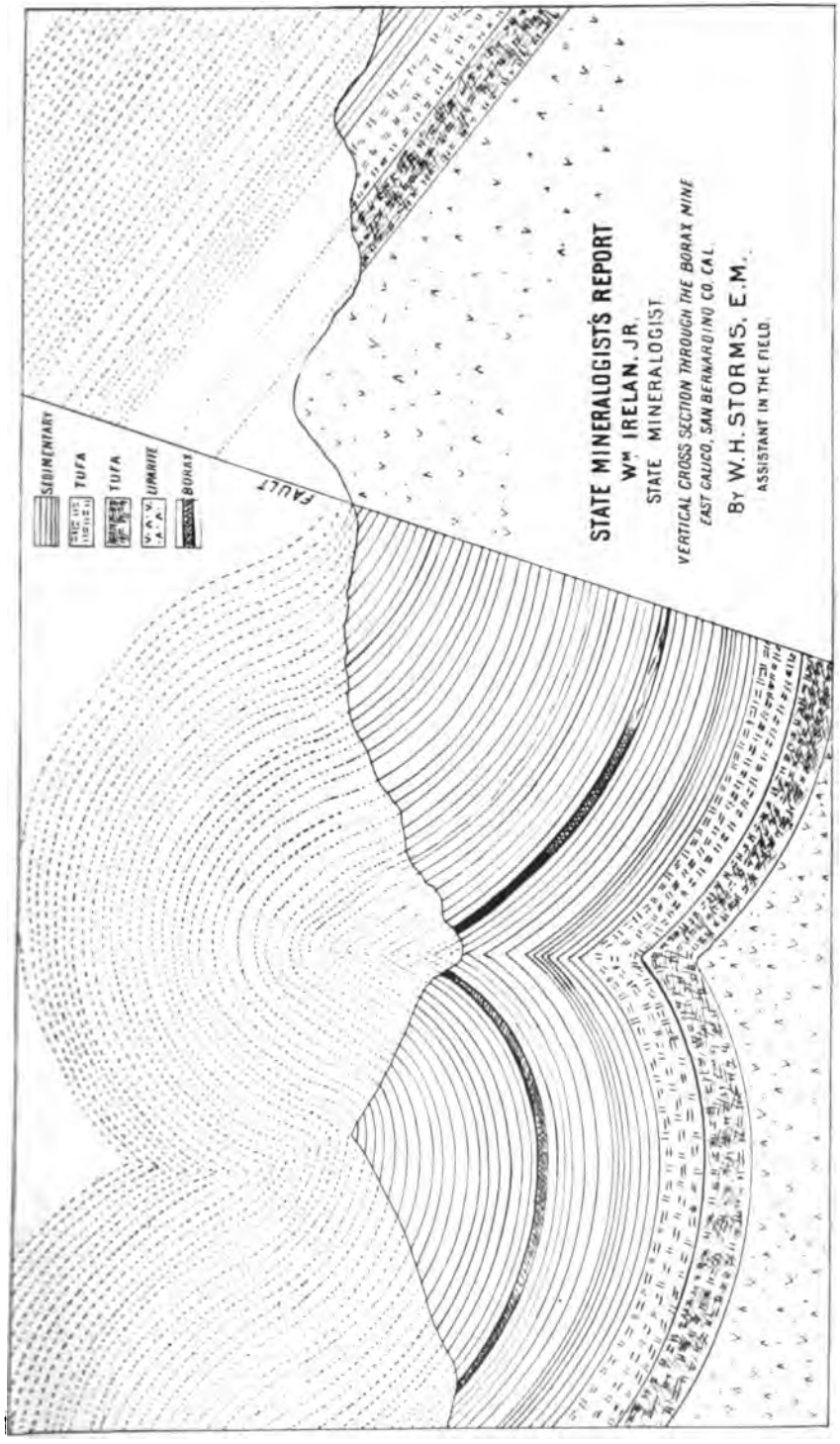
To me it seems that what is now one of the most valuable deposits of mineral in the State was at one time the site of a Tertiary lake of considerable but as yet undetermined size. That although subjected to the same oscillations as the remainder of the region a basin formed, in which the waters collected, carrying with them the mineral salts derived from the rocks of the neighboring country. That finally the climatic conditions became such that the supply of water was less than the loss by absorption and evaporation, and the waters of the lake slowly diminished, it finally disappearing entirely, leaving on the floor of the lake a thick deposit of calcium borate of snowy whiteness.

After the deposition of the borax bed a general subsidence of the region occurred, the waters of the great Tertiary lake once more covering the whole country. Again the sands and finer sedimentary material—the erosion of the mountains—were carried down and found a resting place on the floor of the lake, the borax bed being finally covered with several hundred feet of this detritus. Now, as the same formation in which the borax mine is found, and even the lower members of the rocks of that age, are seen resting upon the high ridges and on some of the peaks of the Calico hills, it would seem highly improbable, to say the least, that these sediments were built up from the ruins of the Calico Mountains themselves, but their source was in more distant ranges.

Besides the regular vein-like deposit of calcium borate found at the borax mine, there are numerous small veinlets in other parts of the district in which calcium borate and gypsum are found filling cracks and cavities, probably as the result of infiltration. So common are these small fissures and beds of borax and gypsum that that portion of the sedimentary strata lying east of the town of Calico is usually spoken of as the borax formation by the miners of the district. To thoroughly investigate all the phenomena connected with these wonderful deposits and their mode of formation would require more time than was at my disposal.

As has been previously stated, remnants of the sediments are still found lying high up on the flanks of the mountains, and even far into the interior of the hills, and there is every probability that the entire region included in the Calico District, as well as the country for many miles around, was at one time buried a thousand feet beneath these stratified rocks.

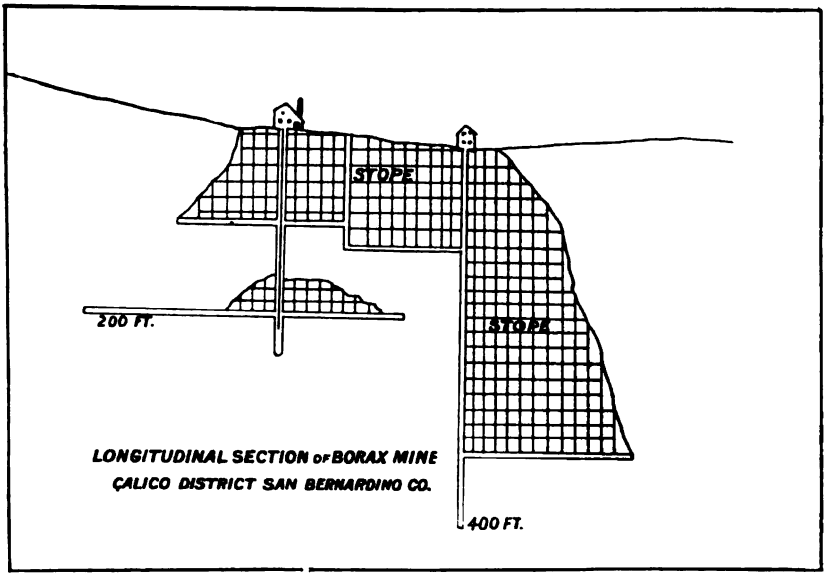
With the uplift, the strata inclosing the borax mine were tilted and folded, and now the sheet of white calcium borate which once lay glistening in the sun on the bed of a desert dry lake stands like a great vein


SEDIMENTARY
TUFA
TUFA
LIMARITE
BORAX
FAULT
STATE MINERALOGIST'S REPORT
Wm. IRELAN, JR.
STATE MINERALOGIST.
VERTICAL CROSS SECTION THROUGH THE BORAX MINE
EAST GALICO, SAN BERNARDINO CO. CAL.
By W.H. STORMS, E.M.
ASSISTANT IN THE FIELD.

traversing the country. There are apparently two of these veins in close proximity to each other, but I believe them to be one and the same, being repeated as the result of an anticlinal fold. An ideal cross-section of the borax mine is here given (p. 347), showing the nature of the folding at that point; it is not drawn to a scale, being a sketch only.

To the southward of the mine is seen a large mass of liparite ,which has been pushed up from below. I had not the time necessary to trace out the line of fracture, but I am of the opinion that it occurs on the line of the great fault shown on the map of the fault system of the region.

The borax vein is from 7 to 10 feet in thickness where it has been exposed in the underground workings. The mineral is the variety of calcium borate called colemanite, named in honor of Wm. T. Coleman. It occurs in glassy crystals, some of them having large faces. Many handsome specimens of this mineral are on exhibition in the Mining Bureau museum. The mineral is mined in the same manner as ores of gold or silver. Inclined shafts are sunk on the vein, drifts and levels run, and the stopes carried up as in any other mine.



LONGITUDINAL SECTION OF BORAX MINE
CALICO DISTRICT SAN BERNARDINO CO.

The material, when hoisted to the surface, is loaded in great wagons hauled by twenty animals and taken to Daggett, where it is shipped to the works in Alameda. The process of extracting the boracic acid from the rock as practiced in these works is not given to the public. It is known that the mineral is crushed and bolted like flour, after grinding with burrs, but the subsequent treatment is not known outside the works.

To the Superintendent, J. W. S. Perry, I am indebted for a sketch of the underground working of this remarkable mine, which is reproduced above.

AGE OF THE UPLIFT.

The geological age of the Calico uplift has not been accurately determined, though there is little doubt that it occurred during the Tertiary age, probably the Oligocene.

THE IRON MINES.

In this county, about 16 miles in a southeasterly direction from Newberry Station, on the A. & P. R. R., and 28 miles easterly from Daggett, are the greatest deposits of iron ore on this coast. They consist of immense beds or masses of hematite and magnetite ore, containing a high percentage of iron, with traces only of sulphur and phosphorus. These mines have been known for many years, and they have had numerous owners by relocation and purchase, but nothing has yet been done with them. Iron men from Pittsburg and Cleveland and elsewhere have visited these mines and secured samples, and all reported favorably on the excellent quality of the ores, but there the matter was dropped.

Located 16 miles from the railroad, and probably 20 miles by any possible line of railway survey, as the grades are heavy, with neither fuel nor water, the problem of their reduction was so formidable that none dared face it, and for years this magnificent property has been waiting for some one with capital and a "process" to come and make the vast wealth available.

THE LAVA BEDS DISTRICT.

This interesting region has come quite prominently into public notice within the past two years. The district is located in a small range of mountains about 35 miles east of the Calico range. The nearest station to the mines is Lavic, on the line of the A. & P. R. R., from which point the mines are 9 miles distant by a good wagon road. Like most other desert mining regions it is destitute of timber, and water is not abundant, though obtainable in the dry lake basin 3½ miles from the mines. The district was discovered about nine years since, and numerous claims have been located. The work of development has been confined to a few of the most promising claims.

GENERAL GEOLOGY.

The mountain range in which the mines of this district occur is isolated from all others, although evidently a part of a chain extending in a northwest and southeast direction for many miles. This particular group of hills is about 4 miles in length by 1½ in width, and consists of rocks, which are all of plutonic origin. They are mostly quartz porphyry of the normal type, consisting of a fine-grained felsitic ground mass, with macroscopical crystals of quartz and feldspar.

Of several thin sections made for the purpose of microscopic study of these rocks, their behavior under the microscope is so similar that general description will suffice for all. The section is characterized by a micro-crystalline to micro-granular ground mass, sometimes to globulitic. The feldspars are so completely clouded as to leave little clue to their

identity. Some still show faintly the parallel lines which are so characteristic of plagioclase, but some of these feldspars are probably orthoclase. These feldspars are plainly distinguishable in the rock mass with the unaided eye. Quartz blebs as large as small peas, with many smaller ones, occur plentifully in all of these rocks. In the section they seem to have been corroded, the outlines being nearly always rounded, though frequently showing hexagonal forms. Most of these quartz grains polarize in brilliant colors. All of the quartzes contain a great abundance of fluid inclusions, some of which show included air bubbles. Numerous very small, colorless, needle-like crystals, which occur in all the quartz, are no doubt apatite prisms. Green, dust-like hornblende as inclusions are not at all uncommon, and in one section a mass of green, fibrous material, having all the optical properties of hornblende, is seen. This inclusion is large enough to be easily distinguished with the unaided eye. There are numerous globulitic, granular, and sac-like inclusions of the ground mass in many of the quartzes, which is characteristic of the quartz porphyries generally. Besides these macroscopic crystals of quartz and feldspar are many hornblendes, some of which are of good size, a few having the typical crystal outlines. It is usually of a bright green color, strongly dichroic, and polarizes in the usual colors. Some of the hornblende is altered to chlorite. Borders of iron ore, probably magnetite, are common, frequently preserving the original outline where the hornblende has suffered great decomposition.

Dark-green basic dikes, which seem to be greatly altered diabase, occur in the district, but have no connection with any of the ore deposits as far as observed.

Numerous dikes, large and small, of a red felsitic rock, occur throughout the district, and seem to bear an important relation to some of the ore deposits. All of the rock is much decomposed, and its identification is not an easy matter. It appears under the microscope to be a finely porphyritic rock, having a somewhat fluidal structure, as shown in the arrangement of the numerous small, lath-like crystals of feldspar. Small blebs of quartz occur quite abundantly. In a general way the rock resembles some rhyolites.

On the northern flank of the range immense masses of red and brown tufa occur, besides great flows of black basaltic lava. These rocks form a terrace-like ridge that extends for several miles along the base of the mountains. Two large cinder cones, one on the northeast end of the range, the other about 4 miles distant in the desert valley to the northward, form prominent landmarks.

The basalt is coarse to fine grained, usually black or dark gray, and is often scoriaceous. It contains plagioclase, augite, and olivine, and abundant magnetite in a micro-crystalline or granular base. Near the foot of the range the basalt has overflowed the beds of tufa, which latter, it is said, contains from a trace to as high as four ounces of silver per ton. As far as I have any knowledge of it, no prospecting has been done in these tufa beds, but the fact that silver exists there at all would lead one to believe that under proper conditions ore bodies of great value may occur.

At the base of the mountains, at an altitude of 1,800 feet, is a dry lake, which drains a large area of country. In this basin water has been obtained by sinking a well 80 feet in depth. Though the well is located

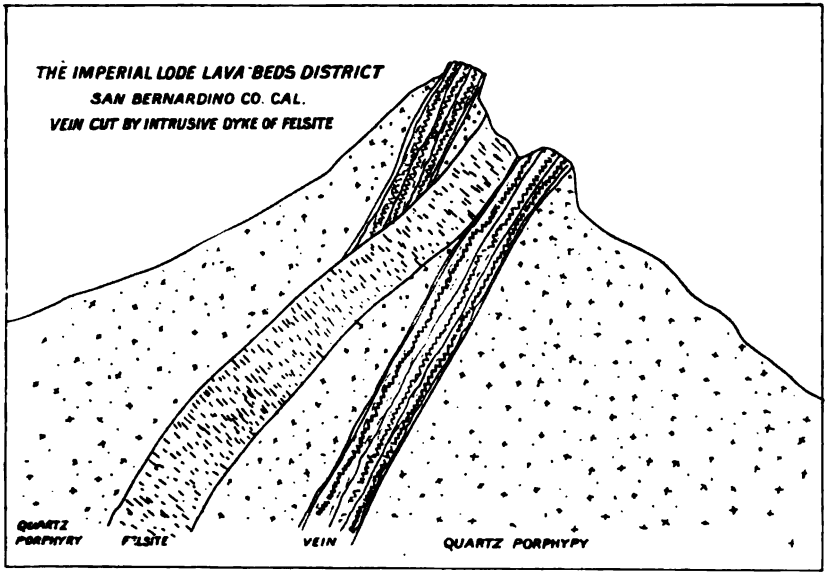
near the edge of the basin, there is little doubt that sufficient water can be obtained in this basin for milling purposes.

The principal vein in the district lies along the north side of the main range, and is known as

THE IMPERIAL LODE.

This great vein, the outcrop of which may be seen for 20 miles, is a "fissure" in every sense of the word, though not a simple one, for it has numerous divergent branches of considerable size. The main fissure, however, is strong and constant, and outcrops boldly for nearly 8,000 feet. It varies in width from 4 to 18 feet. It is everywhere well defined and often shows a banded structure.

The great fissure strikes north 70° west, and dips 65° to 70° to the south. It occurs in the quartz porphyry, which at contact with the vein is usually much decomposed and often shattered and crushed, probably owing partly to the intrusion of a large dike of the red felsitic rock, a tongue of which has cut across the vein about 3,500 feet from its west end. This dike follows the vein for some distance on the hanging wall side coming from the east, gradually nearing the vein until it finally reaches the fissure, cutting the vein in two. Farther westward it again appears on the hanging wall side, showing itself at intervals to the extreme western end of the vein, which comes to an abrupt termination. This felsitic dike is but one of a number that occur in the immediate vicinity.



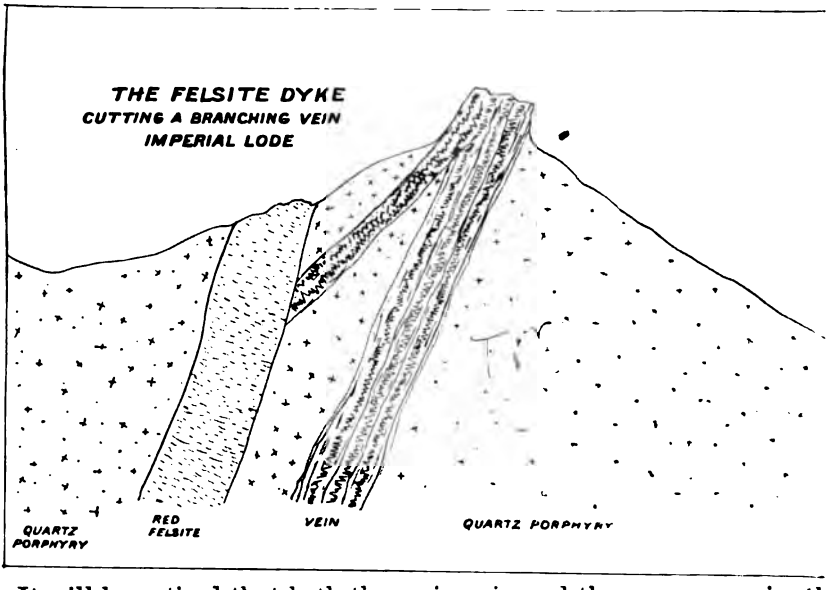
Since the formation of the Imperial lode there has been considerable movement within the vein itself. Slips are numerous, the slickensides showing plainly. The fault planes, as far as observed, are confined within the limits of the vein; however, at no place, excepting where the dike intersects it, did I notice any lateral displacement.

Usually the vein is distinctly separated from the inclosing rock, a

clay selvage marking the line of the fault plane on either side. In some instances, however, where a brecciated condition of the quartz porphyry is found in contact with the vein, the ore has been deposited to some extent in this broken mass, and in such cases the line of demarkation is not at all plain. These occurrences, together with the branching spurs, seem to indicate perfectly the character of the vein, which before the intrusion of the felsitic dike was more simple than we now find it. My conception of the Imperial vein is that a great fissure formed in this mountain range; that at the time this disruption occurred the hanging wall side of the fault slipped downward, causing a further fissuring and crushing of the rocks on that side of the fault. It is a notable fact that all the branches or spurs of this vein occur in the hanging wall country and are directly connected with the main fissure. This idea is still further substantiated by the additional fact that all, or nearly all, the crushing and grinding adjacent to the fault plane has occurred on the hanging wall side.

Occasionally, in the narrower portions of the vein, a banded structure indicates the probability that the ore now fills what was at one time an open crevice, which slowly filled with ore by precipitation from the mineral waters passing along the fault plane.

At one point on the course of the vein, where it is joined by one of the branching spurs, the felsitic dike has intersected the smaller vein. The occurrence is plainly seen in a cut made at this place, where rich ore was found.



It will be noticed that both the main vein and the spur occur in the quartz porphyry, and that the red felsite cuts the smaller vein. The displacement on the surface along the strike of the vein is nearly 40 feet. This does not show in the cross-section.

Since the formation of the Imperial vein the mountains have suffered great erosion; the highest point along the croppings rises fully 800 feet above the neighboring cañons.

THE ORE.

Although the Imperial vein is a fissure of great length and depth, all the material that is included between the porphyritic walls is not pay ore. The ore occurs in shoots of greater or less extent, the same as in any other vein. The gangue is chiefly quartz, having a pearly luster resembling in appearance some light grayish lead carbonate at a casual glance. Accompanying the quartz, though in minor quantities, are baryta, calcite, and black manganese oxide. The value of the ore lies almost wholly in its silver contents, which occur as chloride and sulphide (argentite) accompanying pyrites, chalcopyrite, and iron oxides. The silver sometimes occurs with copper glance in small bunches in solid masses of lead carbonate. Such ores are very high grade. In one of the branches gold is found with only a small percentage of silver, the reverse condition, however, usually obtains. The silver frequently is found in the same shoots with the base ores and in quartz without any intimate association with either lead, copper, or iron. The galena is sometimes very low grade, carrying only 4 ounces per ton in silver. In one shoot the lead carbonate contains over 200 ounces. It is a notable fact that no good ore is found in quantity without copper in some form, either as sulphide (glance) or carbonate. Chloride of silver is also found associated with iron and manganese, without copper or lead.

THE CLAIMS ON THE VEIN.

There are six lode claims located on the Imperial vein, on all of which considerable work has been done. Beginning at the east end, the vein shows itself on the mountain side close down to the desert wash and not far distant from the basalt flow on this side of the range.

The most easterly claim is called the Sampson, and from it has been shipped some rich ore, the claim producing the highest grade ore, I am told, of any mine on the vein. This claim is joined on the westward by the Morning Star, a deep cañon separating them. From the bottom of this cañon it is 800 feet to the summit of the mine, 1,500 feet farther west. The Morning Star Mine has been quite extensively opened by tunnels and shafts, but for several years past assessment work only has been done, as the ore which was found was too low grade to make shipping profitable.

The Meteor, Mammoth Chief, and Desert Queen succeed each other, respectively, going west. On the Mammoth Chief and Meteor, a great deal of work has been done; and it is claimed ore was shipped approximating $40,000 gross value. At any rate the owners have developed their claims and made a good living at the expense of the ore thus shipped from the vein. On the Meteor a shaft has been sunk a depth of 100 feet, at the bottom of which a drift 40 feet in length has been cut along the vein on an ore shoot which was followed down from the surface. At another point on this claim a shaft of 65 feet in depth has been sunk in ore. A drift at the bottom of this shaft is also in ore, 8 feet of which is exposed and the foot wall not yet reached.

The ore at this point is said to average 30 ounces. I was told that the average of the ore throughout the mine was about 25 ounces, ranging from 12 to 75 ounces, and occasionally much more. Numerous cuts, shafts, and drifts, some of them of considerable size, have been made

along the vein on the Meteor and Mammoth Chief for a distance of 800 feet, and although these workings are not connected they have the appearance of being on one shoot of ore. One fact is very evident from an examination of the mine, and it is one of considerable importance. It is, that the ore is of better grade and occurs in greater quantity in the vicinity of the felsitic dike, which, though undoubtedly later than the vein itself, seems to have enriched the ore very materially. The largest shoot of ore I saw has formed very close to the point of intersection of the felsitic dike with the main vein. On the Desert Queen a long tunnel and several crosscuts have exposed ore bodies, some of which contained upwards of 200 ounces silver per ton.

The Imperial lode is one of the most promising veins of which I have any knowledge, but it requires considerable capital to properly and systematically open it. The rock is extremely hard, and the lack of wood and water are drawbacks which prevent the owners from working the mine as it should be worked. It would be difficult to find a vein offering greater natural advantages than are found here, excepting as to wood and water, both of which are obtainable under the usual conditions attending that problem on the desert. Water can be found in the dry lake 3½ miles distant by road, and 1,160 feet below the level of the cañons which cut the vein.

Coal may be delivered at Lavic Station, 5 miles from the lake, for about $9 or $10 a ton. The difficulties are no greater than at Calico, where they seem to have been overcome quite easily. Tunnels may be run in on the vein, getting average backs of about 350 feet above the bottom of the cañons.

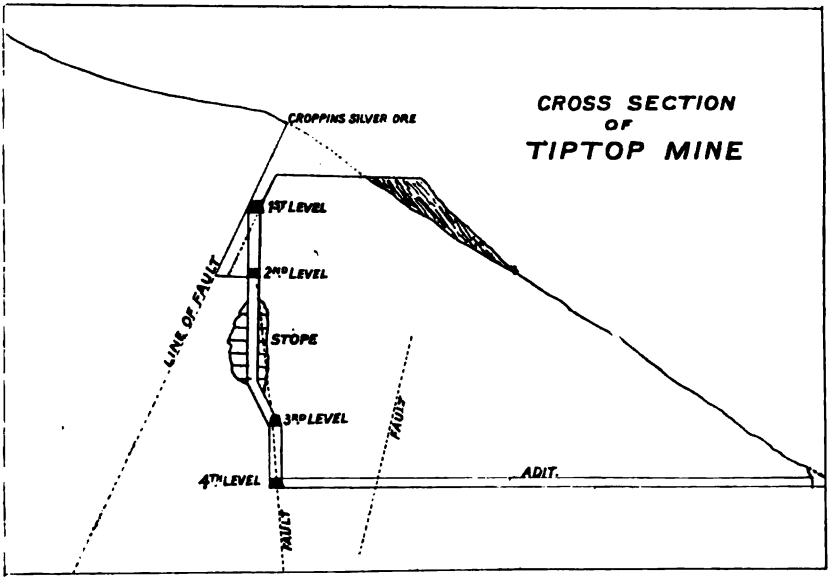
Should ever this great vein be worked on a larger scale with abundant capital, a tunnel started at the lake will cut the vein at an average depth of 1,500 feet. Such a tunnel would probably be about 12,000 feet in length. The ore shoots seem to have an average width of about 5 feet as far as exposed, and none of the workings in ore have ever reached the bottom of a shoot. It is one of the most imposing looking veins I ever saw. On the Desert Queen the soft hanging wall has been eroded, leaving the vein standing exposed for fully 80 feet in height.

THE TIPTOP MINE.

About 4,000 feet south from the Imperial lode there is a mine of unusual character and interest, called the Tiptop. Originally a silver mine, it is now producing a high-grade copper ore, which is being shipped to Swansea, Wales.

The Tiptop was discovered in 1890, by the strong outcrop of an ore shoot. The country rock on both sides of the vein is quartz porphyry, similar to that inclosing the Imperial lode. The ore occurs along a fault plane, or rather a series of parallel faults, as the result of substitution of ore for the original rock. The faulting of the rocks has resulted in an extensive crushing and breaking up of the porphyry along the line of fracture, exposing large surfaces of rock, thus facilitating the deposition of mineral. As mentioned above, the faulting seems to have consisted of several fractures, nearly or quite parallel, between which the rock was crushed or ground to powder. In places this ore body would seem to possess well-defined walls, but moving in either direction along the strike of this zone the "wall" proves to be

simply a faulting plane, beyond which ore again occurs. The result of these parallel fractures is to give to the deposit an appearance of banded structure, like that sometimes noticed in simple fissure veins. This apparently banded structure is entirely due to the planes of displacement.



Doubtless this faulting extends to great depth, though the mineralization is not continuous along the surface for more than 150 feet. At some distance, however, and in line with the strike of the displacement, other ore bodies appear. The ore body where the discovery was made is heavily mineralized with iron oxides, of red, yellow, and black colors.

Much of the original rock has become silicified and bleached to snowy whiteness in the lower part of the deposit, but such masses contain only finely disseminated iron pyrites, low grade in silver. The once sulphuretted ores are so thoroughly oxidized in this surface deposit that they are very porous.

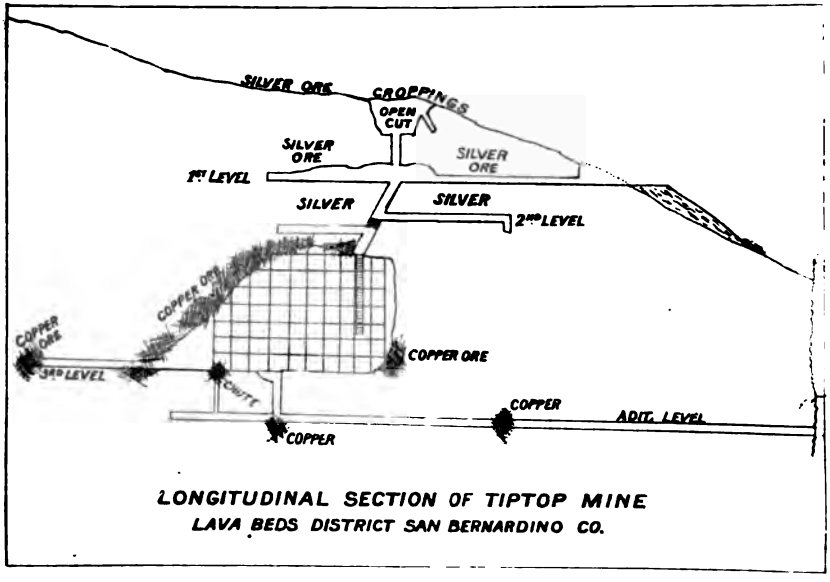
The ores carry on an average about 30 ounces of silver, and for the most part are very free-milling. At the time of my visit an estimate of this silver ore on the dump and in the mine placed its value at, approximately, $20,000. In one portion of this rather remarkable ore deposit considerable quantities of native sulphur occur, associated with a brownish iron oxide and silicious gangue material. As depth is attained the oxidation is less marked, and at 80 feet has apparently given place entirely to sulphuretted ores and silicious rock, low in silver.

The strike of this shoot of ore is north 50° west, dipping northeast at an angle of 70°. At the depth of 65 feet below the croppings, in sinking a winze, which in its downward course follows a slip northward but is vertical as compared with the dip of the vein, a bunch of high-grade, partly oxidized copper ore was discovered. Further development discovered other pockets or bunches of copper ore carrying usually

about 15 ounces in silver per ton. When a depth of 120 feet had been reached a crosscut tunnel was run in 235 feet. The course of this tunnel is north 5° west. The face, however, had not reached a line representing the dip of the surface shoot. The tunnel has been connected by winze with the upper workings, and considerable other development accomplished.

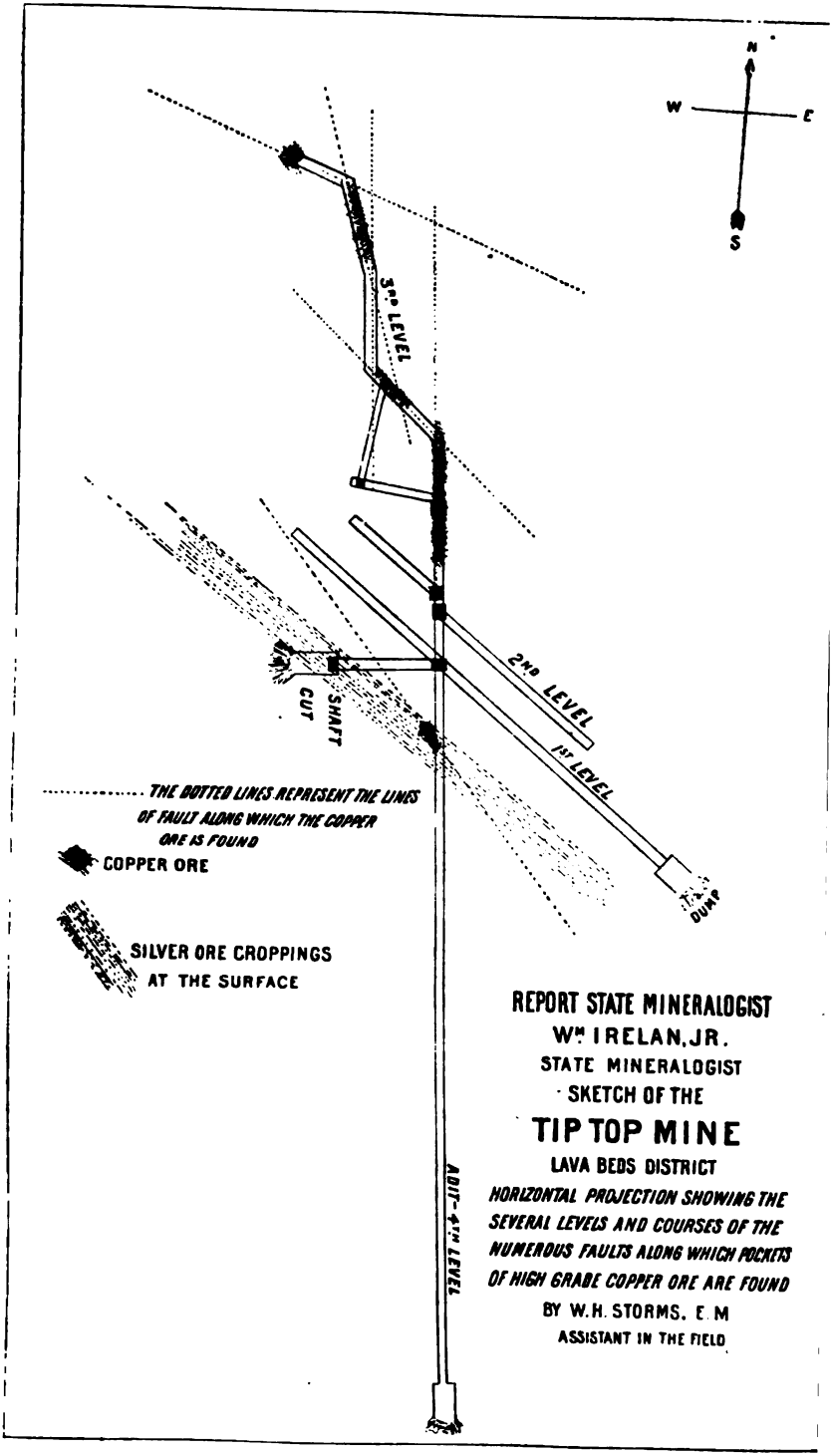
By means of these workings the peculiarities of the mine have been exposed. The series of faults which have resulted in the deposit of a considerable quantity of silver ore have been accompanied by another series of fractures which, while independent of the former, were, perhaps, contemporaneous. The second series exhibit no parallelism, but strike in various directions. Along these fault planes occur bunches of copper ore, principally variegated pyrites (bornite), chalcopyrite, and a black "earthy" sulphide, having a shining streak, not sectile, probably a variety of copper glance.

These ores are sometimes associated with iron sulphide, but most of this class may be easily sorted. One class of ores occurs intermingled with the gangue containing about 15 per cent copper. This ore can be separated on any concentrating machine such as a jig, the resulting product being high grade. The ore shipped to Swansea has averaged over 33 per cent copper and 15 ounces silver per ton.



LONGITUDINAL SECTION OF TIPTOP MINE
LAVA BEDS DISTRICT SAN BERNARDINO CO.

The Tiptop consists of two claims. The easterly one, the Kenton, has little or no development, though copper carbonates have been discovered on the ground. All of the workings of the Tiptop that are in copper ore, it should be remembered, are in the country rock on the foot wall side of the series of faults in which the silver ore occurs, and no drift or crosscut had been run into that zone below 80 feet from the surface. The face of the drift on the third level had exposed about 6 feet of good ore at the time of my examination. The drift at that point was 160 feet from the surface. It is not likely, should a crosscut be



REPORT STATE MINERALOGIST
WM IRELAN, JR.
STATE MINERALOGIST

SKETCH OF THE

TIP TOP MINE

LAVA BEDS DISTRICT

HORIZONTAL PROJECTION SHOWING THE SEVERAL LEVELS AND COURSES OF THE NUMEROUS FAULTS ALONG WHICH POCKETS OF HIGH GRADE COPPER ORE ARE FOUND

BY W.H. STORMS, E.M
ASSISTANT IN THE FIELD

run under the silver ore shoot from the lower levels of the mine, that oxidized ore will be found at that level, but it will be interesting to know what sort of ore may be found there. Indications of copper on the surface are very slight. In a few places stains and thin seams of copper carbonates occur in the fracture joints of the country rock, but there is nothing to lead one to believe that ore lies beneath that will bear shipment to Europe and return a handsome profit to the owners of the mine, yet such is the case.

THE GLADSTONE GOLD MINE.

Less than a mile from the Tiptop, in a northwestern direction, is another property, the Gladstone, locally known as Halberg's Gold Mine. It was located several years ago, and after some development was practically abandoned, but afterwards came into the hands of the present owners, who have developed the ground quite extensively, built a long tramway and ore bins, and established a camp.

Nothing was being done at the time of my visit. The mine is something of a curiosity geologically and mineralogically. The ore body, for there is only one of any consequence developed, occurs in the gray quartz porphyry common to the region. A fault has also occurred here, fracturing the country rock in a manner similar to that in the Tiptop, excepting that here there is but a single, simple fault. The ore body consists of a mass of crushed and broken country rock, portions of which still show distinctly the original porphyritic structure. Generally speaking, however, the original rock has undergone an extreme metamorphosis, resulting, in most cases, in more or less complete mineralogical and physical changes. The porphyry has, by gradual replacement, been changed to solid ore, or been silicified to a dense quartzose, sometimes jaspery, rock. Kaolinization of the feldspars has also taken place. As to the origin of these deposits there seems to be little reason to doubt that the ore was deposited by percolating waters, which derived their contents from the neighboring eruptive rocks. These solutions were carried into the fault plane, and reaching the great chamber or crushed mass, found conditions of a superior nature for the precipitation of the minerals they contained. In the pulverized or finely crushed portions the ore deposition has been most complete, entirely replacing the original rock, while in the brecciated portions the ore occurs as incrustations, filling the smaller interstices, but sometimes penetrating the rock fragments themselves.

The ore body is something over 200 feet in length and 30 feet or more in width at the widest part, but thinning out rather irregularly toward the ends and also downward.

Doubtless it at one time extended some distance upward, but that portion has been eroded. Along the plane of the fault the line of demarkation between ore and porphyry is very distinct, as the two bear not the slightest resemblance, but at the outer edges of the deposit no such line can be discovered. The mineral gradually disappears, leaving only a brecciated mass of whitish rock, which graduates into the normal porphyry. The brecciated condition of the mass is made more plain by the variety of color assumed by the angular fragments. They are various shades of green, red, white, and brown, or yellow, caused by copper carbonates and iron oxides.

Though the original condition of the ore was doubtless sulphide, it now contains, as the result of oxidation, hematite, limonite, magnetite, malachite, azurite, chrysocolla, cerussite, wulfenite, chloride of silver, manganese oxide, and metallic gold. The value of the ore lies principally in the gold contained, though in one portion of the ore body, near ts eastern end, rich chloride of silver ore is found, with but little gold. The physical appearance of the ore is no criterion of its gold contents, as two pieces, with identically the same characteristics, will differ widely in value. One may contain $2 or $3 in gold, the other several hundred. Should ever a mill be erected in the district, this ore can be worked to a profit, though this single ore body will alone scarcely justify the construction of a mill.

On the south side of this fissure or slip is a vein which runs nearly parallel with the chambered vein above described. This vein can be traced for several thousand feet. In character the ore is similar to that found in the Imperial lode. Assays running over $200 in gold have been obtained from this ore, and $50 assays are not uncommon. The vein is quite small, ranging from a mere seam to 2 feet. Scarcely any development has been done on this vein, though it promises better results than the large "vein chamber."

The developments on the Gladstone consist of a shaft 60 feet deep. The first level is cut at a depth of 30 feet from the surface, where drifts have been run for a distance of 30 feet each way from the shaft, on the course of the vein, and a crosscut, 28 feet north. East of this, a 15-foot shaft has been sunk in a good sized cut. A large open cut, 100 feet long, has exposed the upper portion of the ore deposit perfectly. Other superficial work has been done at various points along the vein. A tramway of 1,700 feet has been constructed from the mine to the bottom of an adjacent cañon.

OTHER CLAIMS.

In the vicinity of the mines described in this district are numerous other claims, some of them having considerable development, but all lying idle at the time of my visit. One claim has an 80-foot tunnel, and shows some lead and silver ore of good grade. This claim is patented.

THE ALVORD MINES.

Twenty-three miles northeast from Daggett are the Alvord Mines. The property has changed hands several times, but is now owned by a party of Pasadena capitalists, who have under consideration the reconstruction of their mill, which was burned in September, 1891.

The property consists of six full claims located on one mineral-bearing zone. The strike of the belt is a few degrees south of west. The mine is well equipped. The company also owns a millsite at Camp Cady, on the Mojave River, 9 miles distant from the mines, and valuable water rights at Paradise Springs, 11 miles northwest from the mines, and a spring about 1½ miles east of the camp, which is used for camp purposes only.

The mines lie along a broad zone or belt of crystallized carbonate of lime (calcite), which may be seen for many miles traversing the dark-colored inclosing rocks. A huge dike of porphyritic rock cuts across

this belt at an angle approaching 90°. The principal mineralization of the lode occurs east of this dike.

The country rock is described by F. R. Burnham, E.M., formerly the Superintendent, in his report on the property to the company, as rock more or less schistose in character, through which, at frequent intervals, are intruded eruptive dikes. At the east end of the belt is an accumulation of tufa and basalt. The belt dips south at an angle of 75°. The mineralized portion of this lode extends from the porphyry dike east through three full claims, disappearing finally beneath the eruptive rock and desert wash. The dominant point on the lode is 550 feet above the base of the hill.

The entire lode is gold-bearing, some of the iron rock being extremely rich; gold also occurs in the calcite, though it is usually of a lower grade than where accompanied by the iron. Iron sulphide containing gold has been discovered, indicating plainly the origin of the slag-like iron ores and limonite found on the surface.

To Mr. Burnham's report I am also indebted for information concerning the value of the rock, tonnage, and bullion output to date. He has given arbitrary figures for shipments aggregating $37,000, and an estimate on $13,000 more, making a total of $50,000. This ore was milled mostly at the Camp Cady mill and at Hawley's mill.

An arrastra was used in the early history of the mine. The average assays made on a ten days' mill run just prior to the burning of the mill returned $12 75 per ton. Tailings, during the same period, averaged $1 25. Bullion produced, $1,430. It was found very difficult to sort the ore, though it varied constantly in value from $2 to $20 per ton. About 90 per cent of the assay value, it is claimed, was saved in the mill. In looking through a daily record of assays made in July and August, 1891, I find them to range from a trace to as high as $1,750, most of them running from $6 to $18. Mr. Burnham figures 184,000 tons of mill rock in sight, including all grades, besides large amounts presumed to be available, but not blocked out for stoping. The value of the ore is placed at $5 to $6 throughout.

The cost of milling this ore is placed at $2 50, and mining at 50 cents in large stopes. Should the company now controlling the Alvord Mines determine to rebuild their mill it will doubtless again become a bullion producer.

ORO GRANDE DISTRICT.

The Oro Grande Mining District is located immediately east of the Southern California Railroad, at the town of Oro Grande. It is commonly supposed to embrace all the mines for some miles around, though, in fact each group of mines or hills has been given a separate name, but as these so-called districts are mostly without organization, all the claims and mines will be considered under one head.

The geology of the district about Oro Grande is complex, the formations being uplifted, greatly faulted, and broken, besides the intrusion of dikes of felsitic rock, diorite, and quartz porphyry. I had not sufficient time at my disposal when at Oro Grande to study out the somewhat intricate geological problem, and will describe the region in general terms.

Commencing at the town of Oro Grande, which stands on the bank of the Mojave River, the country rises in a gentle slope toward the hill half a mile distant; gently rolling hills are reached, which in turn give

place to more rugged masses, and finally to a rough mountainous area, the hillsides being almost precipitous. The lowlying country about the base of the hills is mostly made up of schistose micaceous rocks, a quartzose mica schist predominating. The first hills of any consequence are eruptive, mostly a light-greenish felsite and a coarse-grained porphyritic rock. Beyond are prominent hills of a dense, hard quartzite resting upon a crystalline limestone, the highest hills being made up of practically the same materials (quartzite and limestone), in part schistose with some mica schist, jasper, and many intrusive dikes of all the previously mentioned eruptives, prominent among them being diorite of dark-green color.

THE EMBODY MINE.

Within half a mile of the town, and on a lower spur or ridge that makes down from the hills, is located the Embody Mine, which, during the excitement at this locality in 1890, attracted considerable attention. The gold-bearing material is quartzose, micaceous rock of somewhat friable character. The deposit, as I may term it, has the appearance of being an impregnation without definite form.

Were it not for the fact that the shoot of gold rock makes across the strike of the schists, it would resemble some bedded deposits found at the Homestake, Black Hills, South Dakota, where micaceous schists have been silicified and hornblende schists metamorphosed to chloritic schists, the whole carrying gold across a broad zone 1,600 feet in width and 6,000 feet in length. The gold occurs in shoots or vein-like zones, without defining lines of any character. At the Embody Mine, too, little development has been done to make any positive prediction as to the future of the mine. The formation strikes northeast and southwest, and dips 70° southeast.

The country is somewhat broken up, but no considerable masses of shattered rock were observed. The croppings are quite heavily stained with iron oxides of brown and red shades, and this mineralization can be traced some distance. Two shafts, one nearly 100 feet deep, the other about 30 feet, have been sunk on the deposit, exposing rocks of uniform character, all carrying some gold. The width of the gold-bearing zone is undetermined, but it is thought to be from 6 to 20 feet.

As far as I learned, a "mill-run" had never been made on the rock from this mine. Mining operations had been stopped and the property involved in some sort of dispute. The value of the rock was given to me as $8 or $10 per ton.

THE CARBONATE MINE.

The principal mine of this district, and the one which gave the camp its fame, is the Carbonate Mine. It was discovered by a man named Collins, who was working in a lime quarry near by. Collins found croppings of ore—limonite and manganese—containing silver. He developed the property somewhat, but it finally passed into other hands, and is now owned by a Los Angeles company, which has opened the mine quite extensively.

The formation which incloses the vein has a general trend northeast and southwest, the dip at the main workings being not over 20°. Here an inclined shaft has been sunk to a depth of 225 feet on the vein. At the bottom the shaft has attained a vertical depth of about 100 fe

strata are separated by thin seams or fractures, but it is reasonable to presume that this separating line or joint will disappear as depth is attained. The rock is all susceptible of a high polish, and it withstands a tremendous crushing force. It was said by the owners that this had been determined at 28,000 pounds per square inch.

The quantity is large, the variety abundant, and the beauty approaches that of rare onyx. With these unusual conditions surrounding the deposit, its marketing should become an industry of no small importance. The difficulties of transportation are not insurmountable.

LIME AND GRANITE QUARRIES.

Near Oro Grande and Victor several lime quarries are in operation, constantly giving employment to quite a large number of men. Lime is burned in large kilns, which finds a ready market in Southern California. Granite is also extensively quarried near each of these places, and used for building material, curbing, and paving blocks in Southern California cities. This industry employs, all told, about one hundred men.

THE KENT MINE.

Three miles from Hinkley Station, on the Atlantic and Pacific Railroad, between Barstow and Mojave, is located the Kent Mine, a vein covered by two claims. A shaft 80 feet deep and some superficial development have exposed the ore, which varies from 3 to 10 feet in width. The gangue is a rather fine-grained, granular quartz, containing galena and lead carbonate. Assays in gold and silver are obtainable anywhere in the vein. The highest grade carries lead 70 per cent, gold $25, silver 24 ounces. Some of the ore assaying low in lead contains gold and silver in paying quantities.

The property is in a prospective stage only, but is promising. Water can be obtained near the mine, and fuel is but 8 miles distant. The owner bonded the property in May, 1892, and it is at this writing being developed by the prospective purchasers. The ore is of such character that by sorting a milling ore may be obtained, the high-grade lead ore making a very good smelting material.

THE BLACK HAWK DISTRICT

Three years ago the Black Hawk District, 40 miles east of Victor, on the north side of the San Bernardino range, attracted considerable attention through the extensive operations of an English syndicate at those mines. Development was in progress at that time, and it was planned to build a sixty-stamp mill. The quantity of gold rock, however, proved to be smaller than had been anticipated, and a small experimental mill was built; but from a short time after the completion of this mill to date all operations have been suspended, and the probability of the resumption of work is not bright.

The gold occurred in a reddish oxide of iron in bunches and stringers scattered through a crushed zone of limestone, lying along the flank of the mountains. A party, who for a time was in charge of the property, informed the writer that he had worked the rock without sorting, had endeavored to sort it, and had tried screening it, but that notwithstanding every precaution was taken, he had concluded that it could not be

made to pay. The gold-bearing rock was quite rich, but it occurred in too small quantity to make it profitable.

SILVER REEF DISTRICT.

Four miles northeast of the Black Hawk Mines, lying down on the desert, is a formation of limestone and quartzite, resting on a massive crystalline rock, containing quartz, feldspar, biotite-mica, and hornblende. This reef extends from the mouth of Texas Cañon out upon the plain, sloping downward at an angle of approximately 5° for a distance of 4 miles, where it terminates in a bluff 40 to 100 feet in height. Along the entire eastern edge of this deposit it drops off abruptly as though sharply eroded. At the northern end the reef is faced by a low range of hills composed of the above-mentioned hornblende rock. From this point it swings west and with irregular outline extends for 5 or 6 miles toward Rabbit Springs. The entire area, fully 25 square miles, is cut by gulches varying from 20 to 150 feet or more in depth, that have been eroded through the strata and down into the underlying crystalline rocks. These cañons seem to have resulted from natural drainage, being started by slight depressions in the rolling plateau of limestone. On the extreme northern edge at one point, hills of considerable size have been formed by the folding and tilting of the strata. The limestone has been subjected to violent compression, as the whole area is faulted and broken into millions of fragments.

I have examined not less than twenty mining claims on the reef and traveled over the greater part of its area, and am sure I never saw a single piece of limestone that would weigh 300 pounds, most of the pieces measuring under 6 or 8 inches. Considerable masses along certain zones have been granulated, and even pulverized. This fractured rock has all since been loosely cemented by the infiltration of carbonate of lime into the seams. Geologists who have examined this peculiar deposit do not agree entirely upon its mode of formation. Some believe it to be the result of chemical precipitation of carbonate of lime from calcareous springs, similar to the Formation Springs in the Yellowstone Park. There are many things about Silver Reef which would at once suggest the probability of this mode of deposit, but I am very doubtful that such a theory will stand a thorough investigation.

It was asserted that at one time a shaft sunk in the reef passed through the lime deposit and into the "wash" of the desert beneath. On investigation I found that the lime had indeed been cut through, but the underlying rock proved to be crystalline hornblende rock in place, though somewhat decomposed. At any rate it was not desert "wash." Over considerable areas the lime is underlaid by a stratum of quartzite of variable thickness, less than a foot in some places, and again in others 10 or 12 feet. Over certain limited areas quartzite is wanting altogether. The lime is mostly crystalline, varying in color. A small portion is as white as snow, the greater part is gray or bluish, and some of it black.

THE ORE DEPOSITS.

For fully 8 miles along the irregular front of the reef silver ores are found. The ore deposits are usually discovered by the cherty masses of silicious rock, which, being harder than the limestone, stand out from its weathered surface in bunches and small, vein-like masses. Often in

breaking the cherty rocks, stains of copper carbonate are found, and from such rock silver, and sometimes gold, is obtained. Numerous shafts, cuts, and tunnels have been made on these claims, twenty or more in number, and in every one ore of good grade has been found, although the quantity is usually small. A shipment from a claim called No. 1 returned 129 ounces per ton in the Oro Grande mill. On assaying, 20 ounces can be found on any of the claims, and rock of a higher grade running into the thousands of dollars is not unknown on the reef.

The ore occurs usually as bunches, sheets, or stringers, which "roll" more or less, but in a general way follow the stratification of the limestone downward. These stringers are from 4 inches to 2 feet in thickness, pinching and swelling both longitudinally and on their extension downward. The average of the ores thus far found is probably about $50 per ton. The mines have all been opened by the discoverers, who are men of limited means, and no systematic exploration for larger ore bodies has ever been made. They may exist, though there is no surface indication that such is the case. At one claim, No. 9, I took a large sample for 20 feet across the mineralized zone and found it to assay 11 ounces silver with $2 in gold. This rock was taken from a shallow cut 4 feet in width and 5 feet deep, 20 feet long.

The ore deposits occur without exception in zones of limestone that have been crushed into small fragments, together with much very fine material. In a few places I found in contact or close to the ores what appeared to be a thin intrusive sheet of rock of undoubted igneous origin. The original nature of this rock could not be determined, as it was very much decomposed and bleached. It looked like the white porphyry of Leadville more than anything else I could liken it to, and to a great extent has, doubtless, been the source from which the minerals of the ore deposits were derived. In many places the quartzite which underlies the lime rock contains galena, lead carbonate, wulfenite, zinc-blende, iron sulphide, copper, gold, and silver. Some of this rock contains sufficient lead to be classed as a smelting ore.

The ores of the limestone deposits are chiefly chloride of silver and embolite (chloro-bromide of silver), which is usually accompanied by copper carbonate, sometimes a copper-silver sulphide, wulfenite, lead, and iron in various forms, in a gangue of calcite and quartz, with occasionally manganese oxide. Hornsilver in crystals has been found in the fracture joints and in small cavities of a pure blue limestone, taken from a shaft on one of the claims at the east edge of the district. Pasadena, Riverside, Daggett, and Victor people are the principal owners of claims. Timber can be obtained in the main range 5 or 6 miles back of the mines, and abundance of water can be had from the cañons in the neighboring mountains or from Old Woman's Springs, 2½ miles east of the principal claims on the reef.

Altogether the district is a most interesting one geologically and also financially, as the high grade of some of the ore had induced the claim owners to sink considerable money in the development of their mines.

THE GAVILAN MINES.

On the San Jacinto estate, which is owned by an English syndicate, are located the old Gavilan Mines, which years ago produced from quartz veins considerable gold, the rock being first crushed in numerous arrastras, the beds of which, to the number of fifty or more, are still

scattered all about the neighborhood of the mines. In later years, under American management, the quartz was hauled to a stamp mill in the Pinacate District. At the time the rancho became the property of the English people nothing had been done in these mines for many years. During the past two years the old workings have been investigated and a local company organized at Riverside to operate them under lease. At the time of my visit some workmen were industriously engaged in taking down the gallows frame of the hoist and making preparations to vacate the premises, and this in the face of the report that had gone abroad that a good-sized vein of pay rock had been uncovered at the bottom of the mine at the depth of 180 feet. I did not see the alleged ore shoot and could get no satisfaction from the men at work other than vague hints that there was dissension among the Board of Directors.

The veins of the Gavilan Mines are not large, but of good grade, occurring in a granitoid rock. Black tourmaline in a feldspathic and quartz gangue frequently accompanies the gold-bearing rock. The Mexicans worked a large shoot down to the water-line, and judging from the size and number of the dumps these old workings must have been of great extent. The Riverside people had sunk a new shaft at the extreme south end of the mine 180 feet in depth. The entire region is cut by large feldspathic and granitic veins, which course in every direction. These veins are doubtless intrusive dikes of the variety of granite called pegmatite. White scales of muscovite occur sparingly, but tourmaline is abundant.

THE VANDERBILT DISTRICT.

Forty-five miles from Fenner, on the line of the A. & P. R. R., in the eastern part of the county, near the Nevada State line, is the Vanderbilt District. It lies between Palm District and Ivanpah, at an elevation of 6,000 feet above the sea. Numerous claims have been located on the veins of the district and considerable development done. Messrs. Patton, Taggert & Hall own eight promising claims, which it is their purpose to develop extensively. A shaft 4½ by 6½ feet has been sunk on the vein to a depth of 60 feet, besides which a number of shafts of lesser depth and numerous open cuts have been made, all exposing ore of good grade. The vein is of the branching kind. The veins vary from 5 to 30 feet in width, striking east and west, with a dip to the north of 60°. The gangue is quartz, honey-combed at the surface from the oxidation of the sulphurets it originally contained, small disseminated crystals of which (iron, lead, and copper) begin to show in the rock from the deepest parts of the workings. Some of the rock contains a high percentage of lead in the form of galena and carbonate, but it occurs mostly in bunches and is not evenly distributed through the rock. A shipment of 6,963 pounds to the sampling works at Kingman, Arizona, returned an average assay value of $173 50 per ton, most of which was gold. Another lot averaged $44.

Near the above described property Messrs. Simmons & Roberts have sunk three shafts to a depth of 40 feet each, and Campbell & Beatty put down a shaft 100 feet, all in ore of a character and value similar to that found in the other mines. Both wood and water are obtainable in the district, pine timber growing on the hills, and a good stream of water is flowing down into the desert only 1¼ miles distant from these mines. With the character and grade of the ores found in these veins, and the advantages of wood and water, it would seem that these mines

might be successfully operated, particularly as some of the owners are possessed of sufficient means. It is the expressed intention, however, to sink deeper and determine more fully the extent and character of the ore in depth before placing expensive machinery on the ground.

THE IBEX MINE.

Among the mines that have attracted unusual attention in this county during the past year, the Ibex Mine stands prominently in the front rank. It is located 3½ miles from Ibex Station, on the line of the A. & P. R. R., and not over 11 miles north from The Needles. The Ibex property is in the Ibex Mining District, and consists of seven claims, which were located in 1888, now owned by residents of Riverside and San Bernardino. The principal claim is called the Ibex. The vein strikes east and west, dipping at an angle of 45°. Two shafts, one 60 feet and one 52 feet, had been sunk at the time this information was obtained. At the bottom of the 52-foot shaft a drift 38 feet in length has been run on the vein. Surface cuts and trenches are quite numerous on the several claims, and a large amount of quartz containing gold had been exposed. Free gold could be seen in considerable quantity in some of the porous quartz. The quartz is thoroughly crystalline, showing many cavities as a result of the decomposition and leaching out of the sulphuretted minerals it originally contained. These cavities are all lined with minute quartz crystals, which have been deposited evidently since the removal of the sulphides. Rock of this description is full of gold, seemingly. It is so loose in texture that careless handling shakes out the golden grains. John Anderson, of San Bernardino, one of the owners, volunteered the information that from 2 to 4 feet of this rock sampled $100 to $150 per ton. The owners had determined the latter part of April to ship this free-milling ore to The Needles, where a mill was being constructed. Some of the quartz from the lowest workings contains small crystals of pyrite and chalcopyrite, but it would still be classed as an ore susceptible of free amalgamation. The Ibex property had a promising look in the spring of 1892. Its further development will be looked to with great interest by all interested in desert mines.

MONTE NEGRAS DISTRICT.

Near the south boundary of San Bernardino County, and about 75 miles directly east of Mount San Bernardino, a new mining district has been organized within the past two years, and considerable development work accomplished by the claim owners, who, as usual, are men of limited means.

This district is 22 miles northeast of Cottonwood Springs, 16 miles north of Eagle Mountain, and about 6 miles south from Virginia Dale. The belt is about 1½ miles in width and 5 miles in length. The veins trend north and south.

This new district, which has been named the Monte Negras, or Black Mountain District, has attracted considerable attention by the discovery in one of the claims of nuggets of gold and quartz of extreme richness. At the time of this discovery some newspapers in this county published the report that the mythical "Pegleg Smith" Mine had actually been found, which only added to the excitement produced by the bringing into San Bernardino of several hundred dollars worth of specimens.

I visited this new district in the month of May, 1892, and spent several days in making an examination of the claims and adjacent country. The Monte Negras camp is on the south side of the range of hills 45 miles northeast of Walters Station, on the line of the Southern Pacific Railroad, being reached by a fair desert road. By fair I mean a heavy, but not rough or hilly road.

Walters Station is nearly 200 feet below the level of the sea. From that point every foot of the way is up hill, till a divide near Cottonwood Springs is reached, at an altitude of 3,157 feet, the distance being 27 miles; from there to the foot of the wash, which extends 2 or 3 miles from the base of the mountains, down hill 19 miles, where the altitude is 1,300 feet. The altitude of the camp is 1,520 feet. All the mines lying back in the mountains are at higher, though varying, altitudes, the greatest elevation being 3,500 feet, at the Ramona. The neighboring peaks rise from 200 to 800 feet higher.

This district is distant about 35 miles from Cadiz, on the line of the Atlantic and Pacific Railroad. I have never traveled the road, and know nothing of it, although I am told it is a good desert road. Wood is not obtainable at all in the vicinity of the mines, and water is scarce, but has been obtained by sinking a well in a basin at Virginia Dale, a few miles north of these mines. A shaft was sunk 140 feet in the wash 3 miles south of the most southerly Monte Negras mines, but no water was obtained. Bedrock was not reached at the depth mentioned, but it is not unlikely water may be secured by continuing this shaft downward.

I mention all these drawbacks to what I otherwise believe to be promising property, because I think the difficulties may be offset by the fact that the ore is high grade.

The Monte Negras uplift consists, as far as my observation extended, entirely of eruptive rocks, diorite, quartz porphyry, and fine-grained more or less porphyritic rocks, cut by later dikes of felsite and dark-green or black diorite. Epidote occurs in great quantity throughout the region, usually associated with micaceous iron ore, which is found in the form of veins and bunches everywhere. The iron ores contain no precious metals, and are of no economic importance.

The region, although entirely eruptive, and in part volcanic (large fields of basalt occurring on the western slopes) is in the immediate vicinity of a large hill called Pinto, or Painted Mountain, which is made up of metamorphic strata, chloritic and hornblende rocks, quartzite and mica schist predominating.

The mineral-bearing veins of the Monte Negras District are all of the fissure type, and are mostly quite simple in form. The gangue is quartz, carrying iron and copper sulphurets, and the secondary products of those minerals, iron oxide and copper carbonate, with gold and silver. No lead or zinc was observed. The economic value of the ore lies almost, evidently, in its gold contents, the silver occurring so sparingly as to amount to very little. The bullion obtained from these ores is worth about $17 per ounce. The ore ranges in value from $20 to over $100 per ton. Observations on the principal mines of this district, viz.: Great Eastern, Venus, Columbus, Summit, Porcupine, Schiller, Hillerman, Annie Rooney, Ethel, Republican, Ramona, McKinley Bill, and Revenue, have to be omitted in order to condense the report.

SAN BENITO COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

On entering this county from the north a large valley presents itself, bounded on the east by the Mount Diablo range and on the west by the Gabilan Mountains, both having a northwesterly trend and belonging to the Coast Range series. Between them flows the San Benito River, with its tributaries, having likewise a general northwest course until it unites with the Pajaro River, which forms part of the northern boundary of the county.

In general terms, the county is formed by the drainage area of the San Benito River. The two mountain ranges separate it from Merced and Fresno on the east and Monterey County on the west, and are the repositories of the mineral wealth of the county.

The Gabilan range extends south about 75 miles, and has an average width of about 10 miles. Its highest points are found in the Chelone Peaks, 3,800 feet above sea-level, and (35 miles farther north) Gabilan Peak, or, as it is more familiarly known, Fremont's Peak, with an altitude of 3,381 feet.

The San Juan Hills, a part of the Gabilan range, near its northern extremity and adjacent to the valley, are separated from the main range by a narrow and rather abrupt cañon, through which flows the San Juan Creek.

In traveling south up this cañon from the town of San Juan, the first exposures disclose a porphyritic granite, with occasional masses of white crystalline limestone, overlaid in part by a brown sandstone. Farther on, near the property of J. H. Twitchell, on the bank of the creek, some sulphur springs break out, and in this vicinity very good clay, suitable for fire clay, has been obtained. Near the road, on the west side of the cañon, a short distance from this point, the limestone crosses, and has been quarried and burnt in an ordinary pot kiln, furnishing a very superior quality of lime.

Approaching the head of the cañon the limestone is found cropping out on the summit of the hill on the east side. Turning to the west at the head of the cañon and ascending the main range, the peak known as Fremont's Peak shows itself as two points connected by a narrow ridge, the whole mass consisting of metamorphic limestone. South of Fremont's Peak and on the east slope of the Gabilan range, 16 miles from Hollister, the county seat, at Cienega, a large production of a first-class quality of lime is being carried on; the formation is metamorphic, and was fully described in previous reports. Since then another continuous working kiln has been added. The lime is conveyed from the works to Tres Pinos on a steam tramway.

About 4 miles to the north of the Chelone Peaks, near Bear Valley, is a very peculiar and rugged section of the Gabilan range, known as the Palisades, the culminating point of which forms the Pinnacles, so

called from their resemblance to a series of turrets and ruined pinnacles. They stretch along Chelone Creek in a northeasterly direction for several miles, rising about 1,400 feet above the level of the creek; they are largely composed of a very hard conglomerate rock. At the time of the writer's visit it was reported that rich gold-bearing veins had been discovered in the vicinity, but a diligent search failed to verify the rumor. Near the northern end some quartz was found, but no gold could be detected; in fact the whole formation looked very unpromising for gold-bearing veins. Coal is known to exist in the neighborhood of the Chelone Peaks and has been worked to some extent.

Turning now to the Mount Diablo range, in the northeast corner of the county, we have on the dividing ridge between Santa Clara, Merced, and San Benito, on Antimony Hill, a mineral-bearing belt extending about 8 miles north and south, and about 3 miles in breadth, containing veins of antimony and quicksilver, in metamorphic rock. On the east side of the mountain near the base the formation is sandstone, while on the west toward the summit it is serpentine; the veins are in an altered slate, and are found on opposite sides of the mountain, in a quartzose gangue, containing stibnite (sulphide of antimony) and cinnabar (sulphide of mercury); those on the east of the mountain show a preponderance of cinnabar, while the veins to the west have a larger percentage of antimony.

For several years these mines have made but little progress toward development, on account of vexatious litigation about title. Lately the eastern group, known as the Gypsy Mines, have been brought to the notice of Chicago capitalists, which has resulted in preparation being made to erect a 10-ton furnace, and to operate the mines energetically.

The Shriver Mine on the west side is also said to be under a bond to parties who will operate it more extensively than hitherto. The other mines in the district are doing some little work toward development, but have not obtained any mentionable results as yet.

Continuing south no further mineral deposits have been opened until we arrive below Tres Pinos, at the end of railroad communication.

By following the east fork of San Benito Creek, on the road to the New Idria Mines, through the Panoche Pass, we find, southeast of Elkhorn Station, prospects of copper and quicksilver, both lying idle. This is to be wondered at in the case of the copper, after hearing the statements of its value as returned by assay, viz., $57 40 per ton in gold, 3.40 ounces silver, and over 20 per cent in copper. This copper prospect was mentioned in the State Mineralogist's Report for 1888, page 489, as the Antelope Copper Mine. Their tunnel, at that time about 100 feet long, has been extended for a length of 450 feet, at a cost of about $6 per foot. At present only the yearly assessment work is being done. They have struck a 3-foot vein, carrying about 6 inches of ore, coursing northeast and dipping east about 40°. Following the road from here to the southeast through Panoche Valley, a distance of 6 miles, to the conjunction of Panoche Creek and Vallecitos Creek and then into the valley of the latter, the country rock is largely metamorphic, with heavy-bedded sandstones, interspersed with some shale and slate off to the east, and generally much disturbed. Coal outcrops are met with all through this section of country, but nowhere have they developed into productive mines.

In the Vallecitos Valley numerous indications of the presence of petro-

leum and coal are found. As far as explorations have extended this oil-bearing belt seems to embrace an area of about 10 miles long and 4 miles wide, extending over both sides of the valley. In passing through Grizzly Cañon from Panoche to Vallecitos Valley, the road passes two coal outcrops, while a couple of miles to the east may be seen the remains of the derrick over the California Central Oil Company's well that was sunk here some years ago, but without results. It was reported that a new well was to be bored shortly somewhat higher up the cañon. The formation is a heavy-bedded sandstone, with occasional strata of shale; numerous seams of selenite (gypsum) are met with through the sandstone, which weathers out and is found in all the small ravines quite abundantly.

In Primetal Cañon, on the northwest border of this coal and oil belt, about 2 miles from the main road, stringers of coal, or, more correctly, carbonaceous shale and coal seams intermixed, crop out for quite a distance; the largest of these seams is about 2 feet in width, coursing southeast and northwest, and dipping at an angle of about 70°.

At the farm of R. Ashurst, south of the dwelling, in the mouth of a large cañon, seepages of oil and tar led to the sinking of a borehole, but through the lack of proper appliances the work had to be abandoned before any results were obtained, yet the indications were good. Following this cañon up to its head, evidences of oil seepage are seen frequently, but little or no maltha. Bituminous shales and slates pitching under a heavy angle are to be seen exposed in several places along the bank.

Six miles southeast of R. Ashurst's place, on Silver Creek, the San Carlos Company have sunk a well to a depth of 166 feet, which is said to have yielded on first striking it, 25 barrels of green oil in twenty-four hours. While preparing to sink deeper, the lower 20 feet of the borehole caved in, but preparations were being made to start a new well. This company, which is incorporated, controls 40 acres of land. Other wells near Mr. Ashurst's place, which were sunk to a depth of about 104 feet, gave a small yield of black oil.

Three miles southwest of R. Ashurst's place, John Ashurst, in running a short tunnel through a dividing ridge, to convey water across from the other side of the hill, tapped a small spring of sulphurous water, and the white soft sandstone at that point gave off a very strong smell of petroleum, evidences of which were also seen on the water. The owner is anxious to investigate the matter further, for which purpose it is intended to start a borehole at this point. The same party has taken up some coal claims in one of the numerous cañons west of Silver Creek, in Sec. 15, T. 17 S., R. 12 E. The vein crops out along the ravine, and consists of three or four strata of coal with streaks of shale between, the total thickness amounting to about 4 feet. The roof of the bed is clay mixed with some sand and filled with vegetable remains too indistinct to be classified. The foot wall is a light-colored, friable sandstone; the vein courses 50° southeast, and dips to the northeast about 20°. The coal has been tried and found to burn well, but has quite a large percentage of ash. Little has been done in the way of development, as proper title had not yet been secured.

NEW IDRIA MINE.

This mine, which has been repeatedly and very fully reported on, is in metamorphic rock. Since the issuing of the last report of the State Mineralogist no new drifts have been opened; all the prospecting has been done below the Myers and the Bell tunnels, but no new ore bodies have been opened up. Four chutes have been constructed on the pitch of the hill to convey the ore from the upper works to the level of the Slieman planier; two of these are 90 feet long, one 135 feet, and one 600 feet. The ore in running down these chutes passes over a ¾-inch screen at the head; what passes through (tierras), being too fine for the furnace, is reserved for future treatment; the remainder passes on down to the "planier," from whence it is hauled to the furnace nearest the office, 3 tons in a load. Twenty tons a day are brought from the Meyers tunnel and 8 to 10 tons from the upper unsorted metal rock. Five loads are hauled a day. Only one 10-ton furnace is kept burning. The company do their own hauling with two teams. The ore from the upper workings does not average as well as that from the lower works, as it is not quite as hard and contains a larger amount of mundic. The force employed at present consists of twenty-two men in the mine, four furnace men, and six men on the outside. White men receive $3 per day, Mexicans $2 50, and the Chinese $1 50; metal pickers receive $2 per day. A large amount of the "tierras" is on hand to be worked at some future time. The ore at present averages from 2 per cent upwards. During the last year a portable steam sawmill, with a capacity of 6,000 feet, has been erected to prepare the timbers for the mine.

In crossing the divide to the west over to Hernandez Valley, which is about 4,000 feet above sea-level, the formations crossed are mostly metamorphic, flanked on the southwest by a large body of serpentine. On reaching Clear Creek and the head of Hernandez Valley, several idle quicksilver prospects are found.

In passing along San Benito Creek beyond the head of Hernandez Valley, up the cañon about 4 or 5 miles, the west bank consists of a sandstone containing fossil shells; another similar bed can be found well up the creek on the south side; also at the Erie ranch and at the back of the Harrison ranch. Along the banks of the creek, and forming the bed of the same, is a natural cement binding the wash and forming a conglomerate.

To the west of McCoy's Cañon, north of Hernandez Valley, in T. 17 and 18 S., R. 10 E., are some coal seams, but they are not being developed to any extent, and are only of local importance.

San Benito County's mineralogical future development must be looked for in the direction of her economic minerals rather than her metalliferous products, and to derive any benefit from her lime, coal, and oil deposits, she must have better, cheaper, and more extended railroad facilities.

SANTA CLARA COUNTY.

By W. L. Watts, Assistant in the Field.

QUICKSILVER.

During the past two years the force employed at the New Almaden Mine has been somewhat reduced. In March, 1892, Mr. J. B. Randol, who has been so long associated with the New Almaden Mine, resigned. Mr. I. Mahany, of New York, still remains President of the company, and at New Almaden the company is represented by Capt. J. Harry, Superintendent, and R. R. Bulmore, Cashier.

During the year 1890, 12,000 flasks of quicksilver were produced by this mine, and during 1891, 8,200 flasks.

The writer is informed that several new quicksilver claims have been located in the southeastern corner of Santa Clara County, near the San Benito County line, and that some work has been done upon them.

MANGANESE AND MAGNESITE.

At the ranch of R. Favill, on the E. ½ of Sec. 34, T. 5 S., R. 4 E., M. D. M., a vein of manganese has been opened; the strike of the ledge is a little west of north by east of south, magnetic. At the outcrop the ledge shows a width of about 12 feet. The walls appear to be silicious shales; the ore is soft and somewhat porous, and samples are said to have assayed as high as 72 per cent MnO_2.

A short distance southeast from the Favill ranch, a divide is crossed which separates the headwaters of the Mocha from the Colorado Creek; the latter stream joins the valley about 4 miles west of the Favill ranch.

At the headwaters of the Colorado Creek some work has been done on low-grade chrome ore. About 3 miles southeast from Mr. Favill's the road crosses a divide between the Colorado and the Sweet Water Creeks. It is about 1½ miles from the Sweet Water Creek to Dykeman's Cañon, where the writer left the road and ascended toward the southwestern base of Red Mountain. The southwestern slope of this mountain appears to be principally serpentine, and derives its name from the ferruginous nature of the decomposed surface of that rock. On Red Mountain there are several magnesite claims, one of which, the Jarvis, was visited by the writer.

The Jarvis Magnesite Claim.

This claim is owned by Messrs. Jarvis & Ryan, of Newark, Alameda County. On this property large, irregular masses of magnesite crop out. In one place where work has been done, more than 10 feet of magnesite is exposed. The formation upon both sides of the magnesite is serpentine. From this point Mount Hamilton bears about 45° west of south,

magnetic, the intervening country being brush-covered hills, which inclose a few valleys susceptible of agricultural development.

The magnesite appears to occur in an irregular vein, if one may judge from the croppings, which indicate a strike of a little west of north by east of south, magnetic. In several places white croppings of either quartz or magnesite can be observed on the side of the mountain.

The Mammoth Magnesite Claim.

This claim is situated on the northern side of Red Mountain, and a large quantity of magnesite is said to be exposed there. It is owned by R. Favill and J. S. Martin. There are also other claims on the west side of this mountain, owned by Jarvis, Ryan, and Favill. These claims are all situated in the Red Mountain District; they are, however, too far from communication to be at present available.

From the Mammoth claim the nearest shipping point is Westley, on the S. P. R. R., distant about 20 miles, over a rough mountainous country, and it is probably 32 miles from the Mammoth claim to Livermore.

A homestead was once taken up in Dykeman's Cañon, and several acres were cleared and set out in vines. The homestead was abandoned, it is said, because the water in the vicinity was injurious to the health.

In Dykeman's Cañon there are several springs, all of which have a sweetish taste. The barometer at the largest spring showed an altitude of 2,600 feet. From Dykeman's Cañon, the road descends by a gradual slope to the San Antonio Valley, distant about a mile.

From the San Antonio Valley an indistinct road leads for a distance of about 2 miles to the divide between the San Antonio and the Puerta Valleys; upon this divide the Summit Quicksilver Mine is situated.

BRICK.

In 1892 a brick yard was established near San José by the Remillard Brick Company. The plant consists of one continuous Hoffman kiln, the capacity of which is about 12,000,000 bricks a year. About one hundred men are engaged during the season at these brick yards. Only white labor is employed.

SAN DIEGO COUNTY.

By W. H. Storms, Assistant in the Field.

There has been no marked development of mines in this county since the last report was issued, excepting in some of the districts of the Colorado Desert, of which mention will be made. The general geological and topographical features of this county have been so fully described in former reports that to repeat them here is unnecessary. At various times within the past two years new discoveries have been announced, and these have been developed to a greater or less extent, and in some instances, at least, with encouraging results.

HELVETIA MINE.

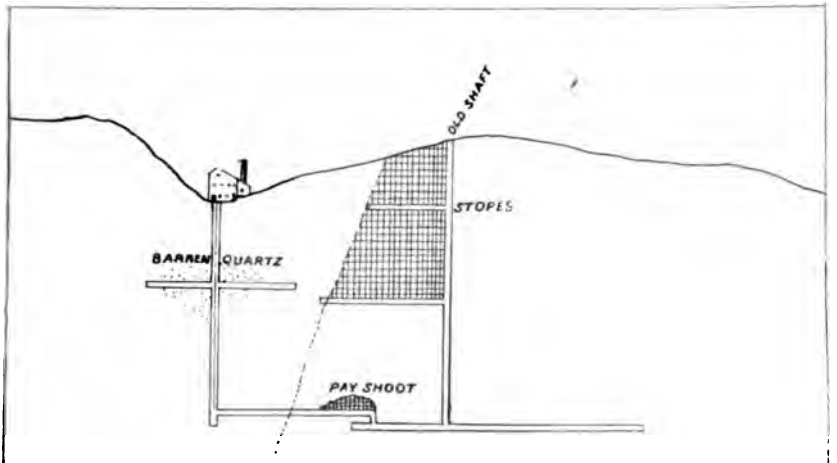
This mine is located a short distance from the town of Julian, and is equipped with a steam hoist and mill combined under one roof. The new shaft, which was started nearly three years ago, was sunk on the vein for 50 feet, at an angle of 75°, at which depth the shaft left the crevice and continued vertically to a depth of 225 feet. From this point a crosscut was started back toward the vein, running at an angle with its strike, the idea being to reach a pay shoot as quickly as possible. The shoot in question was the south extension of that developed in the old workings. The vein was encountered, and the drift continued along its course. At about 30 feet from the point of intersecting the vein in this drift of the shoot was found. It was hard, blue, rather glassy-looking quartz, filled with minute black particles, and showing considerable gold, some of the rock being very high grade.

The drift was continued along the vein, and finally reached a point over the level that had been run south from the old shaft, which is 300 feet deep. This new drift was found to be 14 feet higher than the old level. The mine was completely drained at the time of my visit, and a free circulation of pure air was found throughout the workings. The ground was ready for stoping, but owing to some legal difficulties arising the property was lying idle.

The appended sketch will give an idea of the present development of the Helvetia, which is one of the most promising properties in the district, and a type of the best class of mines of its kind found there.

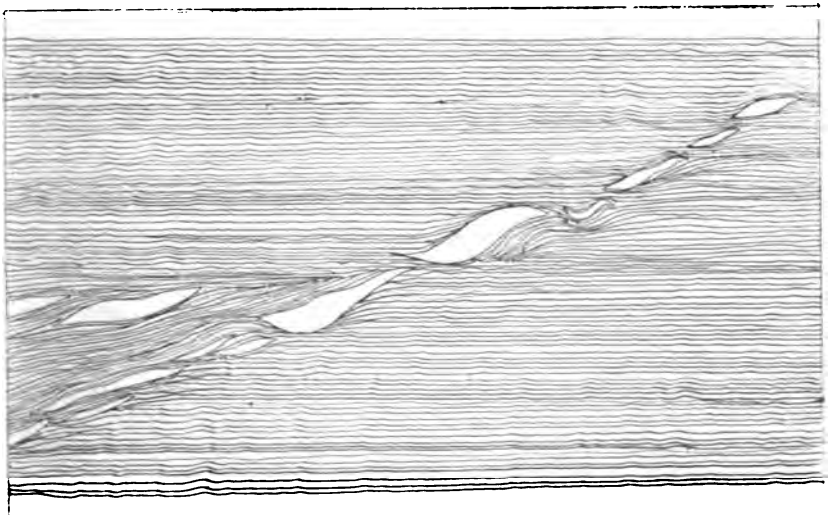
The Helvetia, like other mines of the district, occurs in the crystalline schists, the quartz being found as lenses inclosed in the country rock. Some of the lenses might be mistaken for fissures, but I failed to see one possessing the characteristics of a "fissure."

Nearly all the lenses exhibit a tendency to "make" into the hanging wall side of the country rock, the lenses of quartz following each other in a general direction, but at an angle with the stratification of the schists, and are separate and distinct from each other, being separated at the ends (where they sometimes overlap) by the "leaves," as



WORKINGS OF THE HELVETIA MINE NEAR JULIAN

they may be termed, of the schistose country rock. These lenses were doubtless caused by a compressive stress on the schists, which had a tendency to split them, but was not powerful enough to cause an abrupt fracture. The accompanying sketch may convey an idea of the occurrence of these quartz lenses.



LENTICULAR QUARTZ BODIES IN SCHISTOSE ROCK

By the above sketch it will be observed that there is a tendency on the part of the quartz lenses to follow a given direction, which lies at a small angle across the strike of the schists, and that these lenses are

not connected, but occur independently, though all are the result of the same force which flexed and split the strata.

Other mines about Julian were idle at the time of my visit, the most of them being inaccessible, owing to water in the workings. Considerable money has been expended on the Owens Mine in an attempt to drain and recover the workings, but it was abandoned after several months of work and considerable expense.

More activity was exhibited in the mines about Banner than any other part of the district.

READY RELIEF MINE.

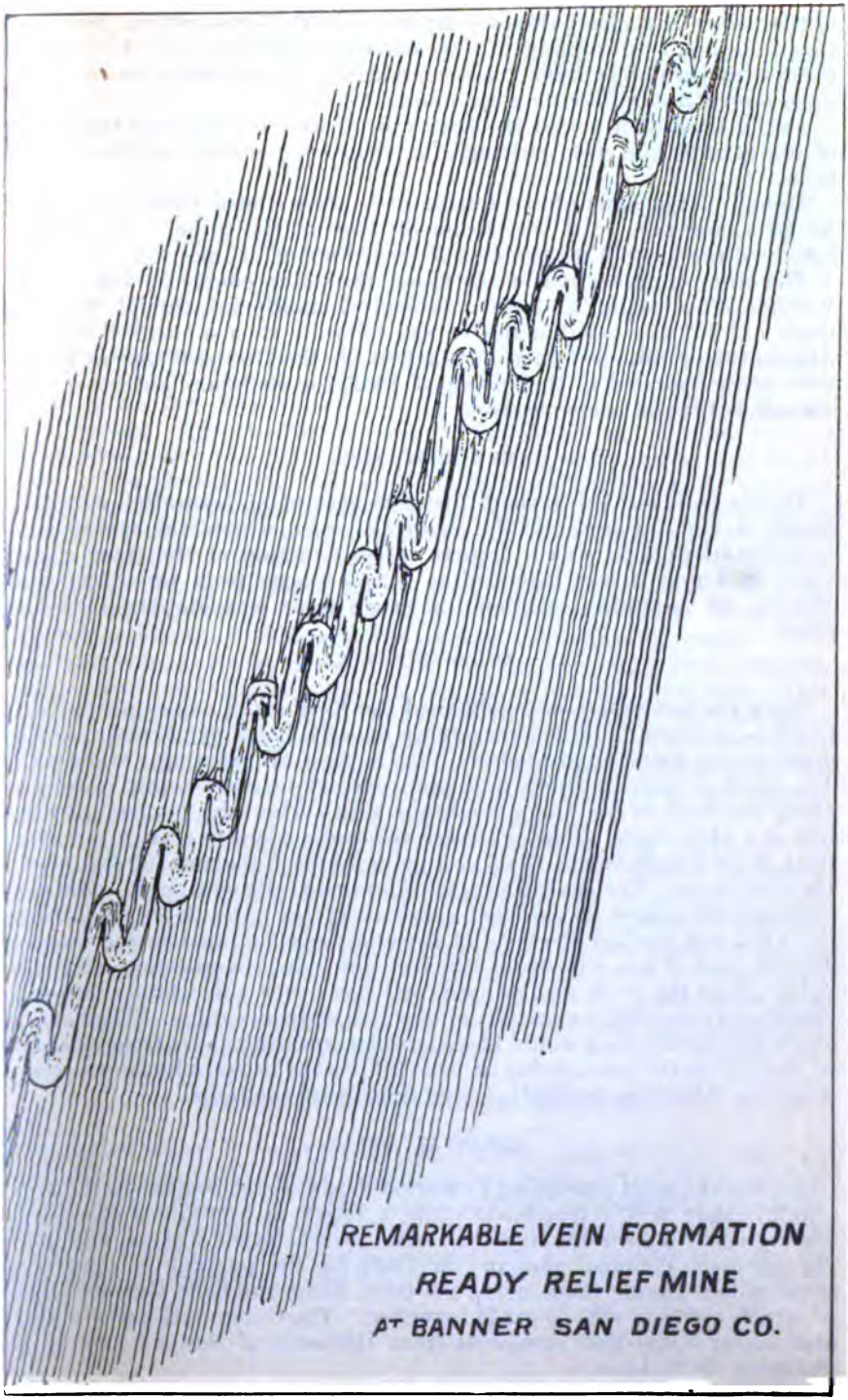
This is the largest and most extensively developed mine near Banner. It has earned considerable fame, not only as a producer, but for the peculiarities exhibited in the formation of its bunches of quartz, which contain disseminated grains and masses of pyrite.

The Ready Relief has several levels, all of which are connected by winzes and shafts. The huge bunches of quartz have, from their peculiar form, been denominated "rolls," and I know of no better term which would convey a clear idea of their appearance. As a result of close observation made at numerous points in the mine and on the surface at the time of my visit, I formed the conclusion that the "rolls" of the Ready Relief Mine simply represent an exaggerated condition of the same sort of flexing of the schists that has produced the other mines of this district. The facts as observed lead me to the belief that the "rolls" or folds of the Ready Relief Mine, and its extensions, both north and south, are the result of a severe compressive stress upon the schists at right angle to a line running nearly northwest and southeast; that this force was exerted in the form of pressure and not of contraction; that as a result of this pressure there is a tendency exhibited on the part of the contorted strata to form a reverse fault and not a normal one, and that this power expended itself before the rocks were forced to yield to the strain to the extent of fracture, the result being an abrupt crumpling of the schists without disruption.

Along this line of disturbance percolating waters have deposited silica in enormous quantities. The schistose folded masses having been completely metamorphosed, massive quartz replacing the crushed and crumpled crystalline rocks, though the lines of its former schistose structure are in many places preserved.

A sketch of a characteristic section is here reproduced, and it may help the reader to form some conception of this unusual occurrence of gold-bearing quartz. The strike of the country rock is about northwest and southeast, and varies but little from this over a wide area. The rock is, generally speaking, a dark gray, rather close-grained, micaceous rock (argillite), having a dip to the east of about 80°. The succession of folds cut across the dip of the schists at an angle about 45° from the horizon.

It will be noticed that in places several of the rolls lie side by side. Where this occurs the pay shoot is very large. The thickness of the individual rolls varies from a few inches to 5 or 6 feet, and where the folds parallel each other a width of 12 to 20 feet or more is not uncommon. These rolls do not extend longitudinally a great distance, but seem to gradually diminish, being followed by others along the strike



REMARKABLE VEIN FORMATION
READY RELIEF MINE
AT BANNER SAN DIEGO CO.

of the vein. It seems quite evident that had the stress which produced this folding or crumpling of the schists proceeded much farther an abrupt fracture must have resulted, and the Ready Relief vein would have been a fissure having a dip of about 45°.

At the time of my visit the Bailey Bros. were overhauling their mill of ten stamps and were putting in a 12-foot waterwheel of the Pelton style.

Though large amounts of quartz have been stoped from the Ready Relief there were still thousands of tons in the mine. Mr. Bailey informed the writer that the rock averaged about $15 per ton.

The other claims which occur along the same course as the Ready Relief are quite similar from a geological standpoint, though none of them exhibit the peculiarities of the folds in such a marked degree. Among the prominent mines on this belt are the Hubbard claims, which were being operated in the spring of 1892, the Redman, Antelope, Cincinnati Belle, and some others.

THE RUBY MINE.

This mine is located a short distance east of and parallel with the Ready Relief. It occurs at the contact of mica schist and syenite. A new five-stamp mill was in course of construction at the time of my visit, in which it was intended to crush quartz from the Ruby and Wilcox, an adjoining location. A small force was employed at the mine.

THE KENTUCK S.

Since the last report was published the Kentuck S came into prominence once more under the ownership of a St. Louis syndicate. A vigorous policy was inaugurated, and for a time all seemingly went well. The shoot of quartz, which had been opened to some depth, crops out along the flank of the steep mountain side. The vein pitches into the hill at a high angle. The manager selected a place to start a new vertical, three-compartment shaft at a point up the hill about 100 feet above the croppings. The shaft was started and was fully equipped. Massive timbers were placed in the most approved style. At a depth of 100 feet the work has reached the level of the croppings, and had cost, it is said, $10,000, and it was still about 125 feet down to a connection with the vein. Here the work was stopped, and has never since been resumed, standing an excellent example of how not to open a mine. The money expended in this shaft would have driven a crosscut tunnel from the base of the hill to the vein, giving at least 500 feet of backs, affording a cheap means of draining, ventilating, and exploiting the mine.

CINCINNATI BELLE.

Among the most promising properties I saw about Banner is the Cincinnati Belle, which has made quite a record as a producer of rock of high grade. This mine, together with several other claims, was purchased by a Pomona company in 1890, for the purpose of operating these mines, among them being the Gold King and Gold Queen Mines, of which mention will be made hereafter. The Cincinnati Belle is situated about 3,000 feet northwest from the town of Banner, and is in charge of D. C. Lane.

The shoots or lenses of quartz which constitute the so-called ore bodies of this mine occur in a general course along the strike of the schists, though each succeeding lens to the northeast "makes" into the hanging wall, as indicated in the cut under the head of Helvetia Mine.

The mine was developed by a tunnel of 168 feet in length, of which the first 40 feet required timbering. Near the mouth of the tunnel a shaft has been sunk on the pitch of the quartz lenses, to a depth of 200 feet. Levels were opened at intervals of 50 feet. The first level at the top had been cut 168 feet along the course of the lead; the second 68 feet; the third 120 feet; the fourth, fifth, and sixth each 50 feet. Each level exposed a bluish quartz rock, which returns in the mill from $18 to $40 per ton. It is free milling, and is treated by a simple amalgamation process.

Though this quartz contains some pyrite, which is auriferous, carrying $8 to $10 per ton, no attempt is made to save the sulphide. The mine makes but little water, and all the quartz and waste are hoisted in a bucket. Pine timber is used, which grows in the neighboring mountains above the mine. It costs 11 cents per running foot at the mine. The property was only under process of development at the time of my examination, and as but little stoping has been done, the cost of mining per ton could not be arrived at. The lenses vary greatly in size, ranging from a few inches to 4 feet. The vein or mineral-bearing zone is accompanied by a fissure, which runs along nearly parallel with the quartz at a distance of a few feet on the hanging wall side. This fault has resulted in the crushing of the country rock along its course.

In this vein, as it may be called, the rock has been completely changed, clay, talcose, and chloritic mineral replacing the micaceous rock. This mineral contains some gold. The inclined shaft has two compartments and is substantially timbered throughout. From the mine the company has graded, along the mountain side, 4,000 feet of road, over which the quartz is transported to the mill in the town of Banner at an expense of 75 cents per ton. The mill contains ten stamps.

The mill is quite complete, but poor judgment was shown in the arrangement by the management under whose supervision it was built, which was before the present Superintendent was in charge. As an instance, the rock from the mine when delivered at the mill is dumped into an ore bin outside the mill. The rock is then taken inside as required and dumped on a grizzly. As usual the large pieces fall on the crusher floor, where they are fed by hand into the jaw rock-breaker, which stands above the level of the floor. This sort of management necessitates extra and unnecessary work.

THE GOLD KING AND GOLD QUEEN MINES

Are located about 4 miles west from Banner, and are owned by the Pomona company, that owns the Cincinnati Belle. Only four men were employed in these mines at the time of my visit, prospecting work only being done. The quartz raised from these workings is hauled 11 miles by road to Banner. The quartz is high grade, and pays well, but no large amount was developed.

THE STONEWALL MINE

Is located about 8 miles southwest from Banner on the Cuyamaca grant, belonging to the Waterman estate. The Superintendent, Waldo S. Waterman, informed the writer that nothing of special interest had been developed in the mine since the publication of the last report (1890).

MESA GRANDE DISTRICT.

A few miles to the northwest from Julian is located the Mesa Grande District, where lenses of a yellowish pellucid quartz of semi-granular texture have been developed somewhat. All of this quartz contains gold, and some of it is quite rich; but nothing of consequence has been done of late, further than to organize a stock company.

ESCONDIDO MINES.

Near the flourishing little town of Escondido are some old Mexican mines, which have been acquired by a San Diego company. The veins are gold-bearing, the quartz having formerly been worked in arrastras with evidently good results, as the surface workings are quite extensive. Within the past two years, however, little has been done on the property.

PINE VALLEY.

The Pine Valley Mines lie 6 miles from the Stonewall and San Diego Stage road, the nearest station being Descanso. Two mills, one of five and one of two stamps, crush the rock taken from the veins in the vicinity. This quartz, it was claimed, would mill over $50 per ton. The veins occur in a formation similar to that about Julian and Banner.

REPORTED TIN DISCOVERIES.

Frequently there have been rumors of the discovery of tin stone in San Diego County, but up to this time no such ores are known to exist outside of the property known as the Temescal Mines, which are located on the line of San Bernardino and San Diego Counties. However, in the large crystalline area which extends over a considerable portion of San Diego County, it would not be strange to find tin stone under conditions similar to those which obtain in the Harney Peak region in the Black Hills of Dakota. There the cassiterite is found in good-sized crystals and finely disseminated grains in a matrix of coarse-grained granite, which has been thrust up through the schists in the form of intrusive dikes of greater or less size. It usually is associated with tourmaline, wolfram, and other black minerals, making it difficult to distinguish it without making a test of some sort. The search for tin in San Diego County has been confined to looking for a black rock similar to that found in the Cajalco Mine.

DULZURA DISTRICT.

The Dulzura Mining District is 30 miles east and a little south of the city of San Diego, in a range of rather rugged mountains. Metamorphic rocks occur frequently, but masses of igneous rock have been intruded

and constitute large hills throughout the district. Among these rocks are a light, greenish-gray feldspar porphyry, a dark-green, fine-grained diorite, a black aphanitic diorite, sometimes porphyritic, and a light cream-colored or greenish-white felsitic rock. In the immediate vicinity of Dulzura the latter rock occurs in the form of immense dikes striking northwest and southeast, crossing Cottonwood Creek to the south into Mexico. In one of these great dikes, which is several hundred feet in width, the mines of the district are found. They are principally chambered veins occurring on the line of a fault plane which has fractured the felsite, the hanging wall side of the slip going down, the movement causing the rock to become crushed and broken. Percolating waters have carried into the crushed mass mineral solutions, which have deposited the ores, chiefly iron sulphurets, where the most favorable conditions were found along the line of this fault plane. The subsequent oxidizing of the masses of ore thus formed has stained the rock a bright or dark red and sometimes yellow.

The rock contains gold ranging from a trace to $20 or over per ton. It was said the average was about $8. The oxidation of the ore bodies does not extend to any very great depth, the result being the occurrence of sulphuretted ores comparatively near the surface, though it was claimed by the mine owners that the sulphurets contained sufficient gold to make concentration and treatment by chlorination profitable. The mines are quite interesting from a geological point of view, and may, in time, prove equally so from a financial standpoint. No machinery had been built at the time of my visit. The felsite throughout the district, whenever observed, contained a considerable amount of pyrite, the surface rock nearly always presenting a highly mineralized appearance.

JAMUL CEMENT ROCKS.

The Jamul Portland Cement Mine and works are located on the Jamul rancho, 22 miles east of the city of San Diego. The company began the construction of expensive works in the spring of 1890, which were not completed until June, 1891, at a cost of $50,000. Seven kilns were constructed, together with large buildings. The capacity of the works is about 150 barrels a day. When in operation over forty men are employed at the mine and works.

The transportation problem proved a more serious one than had been anticipated, it costing more to haul cement from Jamul to San Diego than it costs to bring English Portland cement to California by vessel. The cement made by this company has been quite extensively used throughout Southern California.

ASBESTOS.

The John D. Hoff Asbestos Company, of San Diego, is operating an asbestos mine in the San Jacinto Mountains, from the product of which a variety of fire-proof material is made, including roof paints, roofing, boiler and steam-pipe covering, fire-clay goods, etc. This is the only asbestos concern in the southern part of the State, and the business seems to be on the increase. The works are located near Pacific Beach, 7 miles from San Diego. Asbestos is also found near Palm Springs, in the San Jacinto Mountains, and several miles east of Indio.

PINACATE DISTRICT.

Near the line of San Bernardino and San Diego Counties, about 5 to 8 miles west from the town of Perris, are the mines of the Pinacate District, all being veins of quartz-bearing gold. In past years this district has produced a large amount of bullion, the quartz being worked in arrastras, the beds of over a hundred of which still may be seen scattered about.

There are numerous springs of small size in the district, but timber is very scarce. The formation is syenite and granite principally; occasionally schistose and gneissoid rocks and quartzites being observed. The entire region is metamorphic, excepting a few dikes of granite (pegmatite) and quartz porphyry. Diorite is found near the Good Hope Mine. The region is one easily accessible, and but 4 to 8 miles from a railroad.

STEELE'S MINE.

To the northwest of the Good Hope Mine is the Victor Mine, formerly "La Plomo." This mine is now better known as the Steele Mine. The vein is a foot or more in width, consisting of a highly crystalline quartz, in which is disseminated a small amount of iron and lead sulphuret and lead carbonate. The rock is quite rich in gold, some of it showing gold without the aid of a lens.

A tunnel 900 feet in length had been run to develop the vein, on which an inclined shaft had been sunk to a depth of 200 feet. Besides this work there were numerous other superficial workings, in which quartz of good grade was exposed. The vein occurs in a region of metamorphic rocks, the foot wall containing much quartz and biotite mica. The hanging wall is dark gray color, and quite fine-grained in texture. Hornblende crystals are plentiful throughout the rock. Other rocks in the vicinity are mica schist, chloritic rocks, quartzite, and other more massive crystalline rocks. Granitic dikes (pegmatite) cut the formation on all sides, none of them being very large. These dikes are characterized by their exceptionally coarse crystallization. Good-sized tourmalines, of jet black color, are numerous in the granite.

THE ROSALIA.

About a mile northwest from the Victor is the Old Rosalia, now the Santa Rosa, which is opened along the surface for over 1,000 feet by cuts and shafts. The upper portion of the vein was worked out years ago, but new capital has been interested and a new shaft was being sunk at the north end of the property.

The inclosing rock on either side of the vein is very soft and much decomposed, requiring more timber than had ever been used by the former operators. The mine has produced a large amount of gold, which was extracted by working the quartz in arrastras, and in later years in a mill, which still stands on the mine. At the north end it was understood that the shoot of pay rock was still intact, and it is to recover this that the new work was being inaugurated. The balance of the shoot to the south has all been worked out down to the water-line.

THE SANTA FE.

Not over half a mile from the Rosalia is the old Santa Fe Mine, which in days gone by was a producer of gold, but its workings had long been abandoned.

THE SHAY MINE

Is also in the Pinacate District, 6 miles west of Perris. Several holes have been sunk on the vein, but the entire lower portion of the mine was flooded and could not be examined. The quartz is a bluish, ribbon-like rock, and carries considerable gold. The owner from lack of means is unable to work the mine.

There are numerous other mines or veins in the district, many of which have been worked in former years by Mexicans, who coyoted about, working the narrow seams and crushing the quartz in arrastras. These veins are now abandoned, and no one seems to have sufficient faith in their value to undertake anything like systematic development. The veins mostly lie quite flat in granite or syenitic rocks. They are usually from 4 to 16 inches in thickness and extend some distance. Roads are constructed to nearly all of them. It seems like a region promising good returns on small investments. One ten-stamp custom mill could crush the rock for all the veins of this district. I was informed that much of the rock returned from $60 to over $100 per ton.

THE MENIFEE MINE

Is located south of Perris about 8 miles. The vein contains gold-bearing quartz. The foot wall is a chloritic schist, back of which lies a syenitic rock. The hanging wall is syenitic granite, the hornblende having changed partly to chlorite. The vein is from 1 foot to 30 inches in width, and strikes northeast and southwest, dipping west 80° to a depth of 40 feet, where it flattens out to 65°. The quartz mills about $15 per ton, and contains but a small percentage of sulphurets. There are four shafts on the vein, varying from 35 to 60 feet in depth, the main shaft having a double compartment, being 5 by 11 feet. They have a five-stamp mill.

THE WALKER CLAIM.

Within a mile of the Menifee, in a northeasterly direction, a new discovery was made in the spring of 1892 of a quartz vein which occurs on a low mound at the base of low, rolling hills. The vein was small, 4 inches to a foot, quite heavily mineralized, but much broken. Two distinct faults occurred in a length of 90 feet, where the vein had been exposed. Two shafts were down 30 feet each, and water was coming in. The finding of specimen rock had created quite an excitement in the vicinity, and visitors were numerous. The rock, I judged, would pan out about $40, but too small an amount of work had been accomplished to make any estimate of the value of the vein possible.

CARGO MUCHACHO MINE.

In the Cargo Muchacho District, 30 miles in a northerly direction from Yuma, the Cargo Muchacho Mine has again been in operation within the past two years. The owners moved the mill from the Pay-

master Mine to a site near the former property, laid a double pipe-line 14 miles from the Colorado River, and have supplied the camp with water in this manner. The latest reports from the district are to the effect that the mill and mine are being operated steadily, with satisfactory results.

THE PASADENA MINE.

About one mile north from the Cargo Muchacho is a vein on which several locations have been made. Of these the Pasadena and Peterson claims are most prominent. The vein covered by the locations has been quite extensively opened, and possesses many of the features of the Cargo Muchacho.

The quartz was sent, at no small expense, to a mill at El Rio, on the Colorado River. The expense of mining was seldom less than $2 a ton; transportation to the S. P. R. R. at Ogilby Station, 6 miles, $2 50; transportation by rail to El Rio, 14 miles, 50 cents a ton, making at least $5 a ton. The mill was leased at $10 per day, to which the expense of milling was added, making fully $4 a ton more, or about $9 in all. It was claimed that the rock averaged $16. Doubtless some of it did, but it is probable the expense really exceeded the figures given.

With water pumped into the district it is quite possible that this mine, and the Peterson claim adjoining, may be operated at a profit, which under former conditions was impossible. There are many other gold-bearing veins in the region, but none of them are extensively developed.

EAGLE MOUNTAIN.

Unusual activity has characterized operations about that portion of the Colorado Desert, about 90 miles east of the San Bernardino Mountain, near the line between San Diego and San Bernardino Counties. The Eagle Mountain District is one of these localities. The discovery of rich placers in the dry gulches of that section resulted in a more thorough investigation of its mineral resources and in the finding of some very rich gold-bearing quartz. Considerable work has been done on these claims and the prospects are considered very flattering.

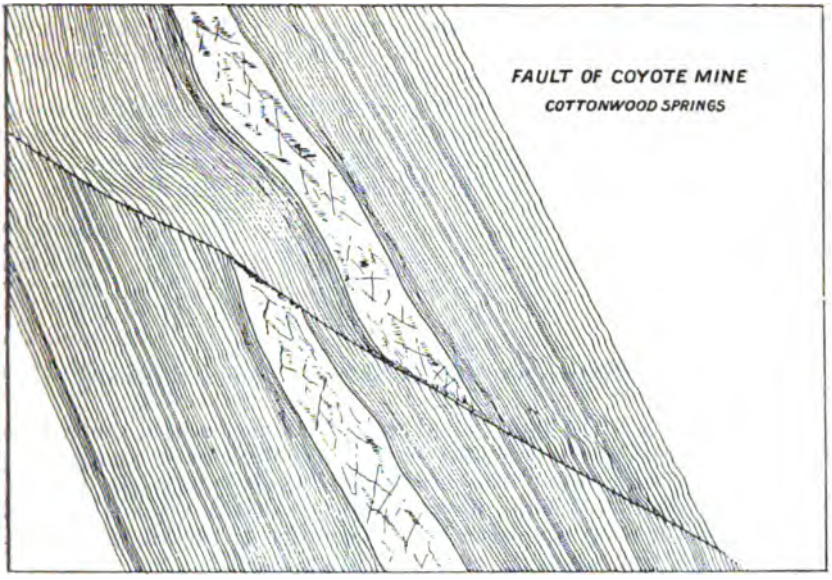
A cemented basin has been constructed to catch the rain water that falls during the winter season, with which it is intended to work the placer mines. The discoverers of these mines, it is said, took enough gold from the gulches, in making the basin referred to, with a dry washer, to pay for making and cementing the basin.

COTTONWOOD SPRINGS.

Twenty-six miles in a northeast direction from Walters Station, on the line of the S. P. R. R., at an altitude of 3,004 feet, is Cottonwood Springs. A range of mountains, in which occur granitic and metamorphic rocks and eruptive dikes, strikes east and west across the desert, and in these occur several springs. There is but one mine in the immediate vicinity of the springs, and this is known as

THE COYOTE MINE,

Where a reading of the aneroid indicated 3,300 feet. The formation in which the Coyote vein has formed is micaceous and hornblende schist and gneissoid rock; hornblende granite and dikes of diorite also occur



in the vicinity of the vein. The Coyote Mine is a quartz vein from 2 to 4 feet in width. The rock is iron stained and occasionally shows free gold. The vein is developed by two shafts, one about 20 and the other nearly 80 feet in depth, and strikes 5° north of east, having a dip of 46° to the south. The vein appeared to cut the formation at a small angle. A fault, which has occurred within the vein, had evidently puzzled the owners, as at the bottom of the 20-foot shaft they had developed 8 feet of what looked like solid quartz. The vein is really but 4 feet in width at that point, but the fault cutting downward at an angle of 45° and crossing the strike of the vein at an angle of 27° had allowed the hanging wall side of the fault to slip downward, thus doubling the width of quartz, which was much shattered. The miners had quit work, leaving what they considered well enough alone. In the deeper shaft the fault had carried the hanging wall down and to the east a few feet, and the vein was lost altogether. A short drift had been run into the hanging wall, but not finding the vein, work had been suspended. The vein lies on the foot wall side and not more than 4 or 5 feet from the line of the slip.

SALTON LAKE.

By E. B. Preston, E.M., Assistant in the Field.

The Coahuila Valley, in which Salton Lake is situated, is 90 miles long and from 10 to 30 wide. It separates the San Bernardino range of mountains from the San Jacinto, and forms a part of the great Colorado Desert in San Diego County. In its deepest portions it is 275 feet below the level of the sea; the area of the depressed region is over 1,600 square miles. In its northern portion the valley consists of sandhills and dunes, the former caused by the accumulation of the sand around the

scrub and bushes growing in the desert. The southern portion is bare clay. On the borders of the desert palm trees of the fan palm variety occur in a few scattered clusters. The Southern Pacific Railroad passes through the valley on its way to Yuma.

In that part of the depression adjacent to the railroad station of Salton is a salt marsh, where the New Liverpool Salt Company's works are located, and where a fine quality of table salt is produced, containing, according to an analysis made by Thomas Price, of San Francisco:

Chloride of sodium	94.68 per cent.
Calcium sulphate	.77 per cent.
Magnesium sulphate	3.12 per cent.
Sodium sulphate	.68 per cent.
Water	.75 per cent.
	100.00 per cent.

The brine from which the salt is obtained shows a density of 27° Baumé.

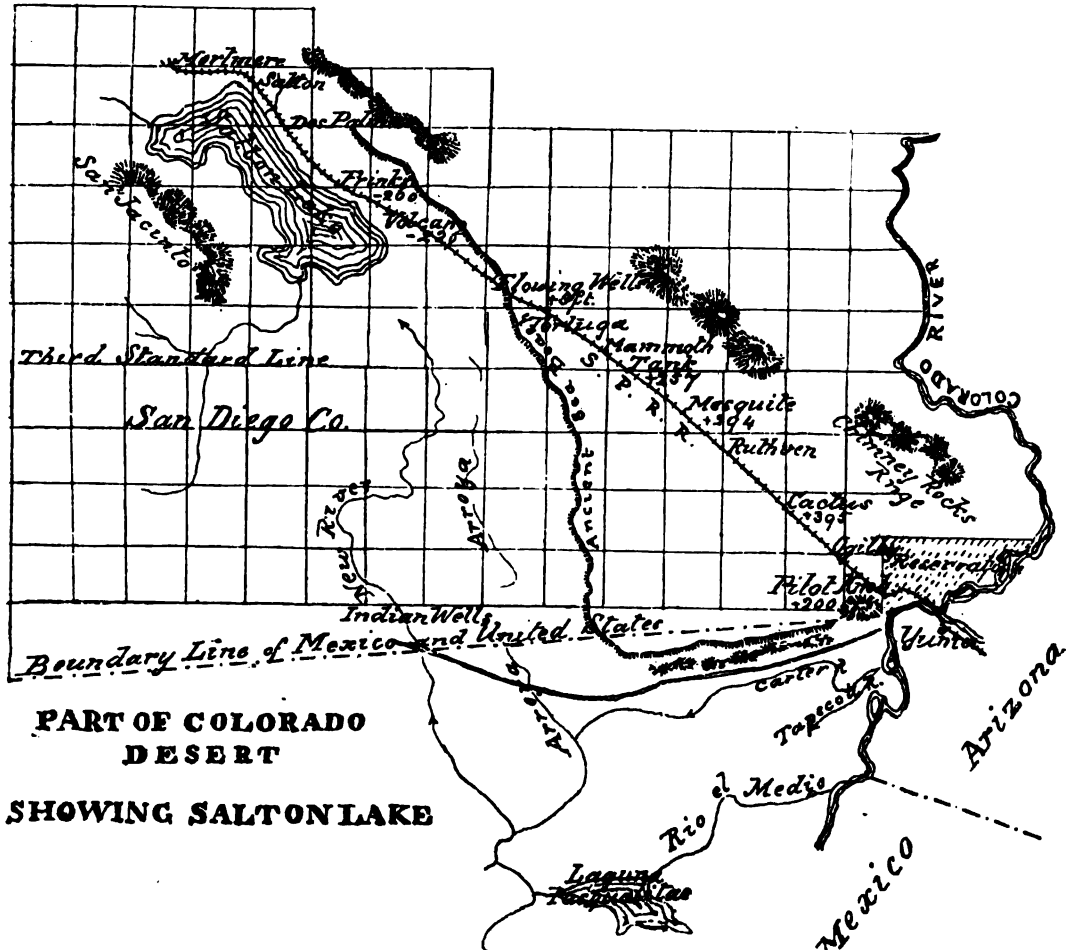
The company's works are situated about 3,000 feet west of the railroad track, and consist of the salt mill and a large storehouse, connected by track with the main line. This branch line extends into the marsh a distance of over 10,000 feet. Beyond the end of the track a borehole was sunk by the company, with the expectation of obtaining water, to a depth of 300 feet, when the work was interrupted.

The strata passed through during the sinking throw some light on the past condition of the desert depression, as well as furnishing some points that may have a bearing on the flooding of this section.

The top covering consists of 6 inches of black mud, resting on a crust of chlorides of sodium and magnesium, 7 inches in thickness. The drill on passing through this crust dropped through 22 feet of a black ooze, containing over 50 per cent of water. Tests of the ooze made at the State Mining Bureau laboratory showed it to consist largely of chlorides and carbonates of sodium and magnesium, the soda salts predominating, besides fine sand, iron oxide, and clay, and a small amount of organic matter. The ooze was resting on a hard clay bottom, through which the drill passed for the entire remaining distance, only varied by two or three streaks of cement. From the shore line of the marsh toward the adjacent mountain ranges, the soil consists of a fine sand, containing clay and a notable quantity of mica, and is strewn with well-preserved shells of *Planorbis ammon*, Gould, *Physa humerosa*, Gould, and *Amnicola protea*, Gould.

In a few spots near the northwest end of the marsh the accumulated cases of a species of Caddice worm are found. Northeast of the marsh the surface slopes gradually upward to where the remains of an ancient sea beach are to be seen, stretching to the south and east to where the Colorado River cuts through on its way to the Gulf of California.

Behind the beach extends a mesa to the foot of the San Bernardino range. Across this mesa are evidences of heavy floods coming down the cañons of the back range, carrying large quantities of debris with them, mostly bowlders of mica schists and granitoid rocks, with some quartz intermixed. On the west side of the marsh the surface has but little elevation until the granitic bluffs of the San Jacinto range are reached. These bluffs are coated for a distance of about 25 feet above the plain with a sponge-shaped incrustation from 2 to 3 inches thick, consisting largely of carbonate of lime, chloride of sodium, sand, clay, and oxide of


Kane Springs
Salton
Dos Palmas
Travis
Volcano
San Jacinto
Flowing Wells
Mammoth Tank
Mesquite
Ruthven
Chimney Rocks
Chimney Ridge
Laguna
Pilot Knob
Indian Wells
Yuma
Carter
Tapesco R.
Arizona
Rio el Medio
Mexico
Laguna
Third Standard Line
San Diego Co.
Boundary Line of Mexico and United States
COLORADO RIVER
S. P. R. R.
Colorado R.
Arroyo
Antelope
Arroyo
PART OF COLORADO DESERT
SHOWING SALTON LAKE

iron; under the glass some of the pores are seen to contain minute shells of the same varieties as found on the sand of the plain. Where arroyos have been cut through the sands of the plains to the depth of several feet, the exposed sections show a stratified arrangement of the sand, having between the layers a thin division of the same varieties of shells as found on the surface, the whole resting on a firm clay bottom. From the position and regularity, as well as the quantity of these shells, on top of the different strata of sand, while but few are seen scattered through the sand layers, a periodicity of the conditions favorable to their existence and growth, as well as a comparatively sudden cessation of the same, must be inferred. These conditions mean an occasional flooding of the depression for a period of time, during which a shallow body of water was maintained, which evaporated as soon as the water supply was shut off. In what manner this can occur will be shown later on. The plain supports a scant growth of desert shrubs, with some mesquite bushes in the vicinity of the few springs that are found scattered over the desert, most of which are saline. The presence of the extensive line of sea beach proves that at some time the gulf has extended much farther inland than at present, covering the whole of this depression. The Colorado River, in its course south to the ocean, built up a flood plain on a higher level that finally shut off the western part from a direct communication with the sea, and evaporation, with a gradual uplifting of this whole section, finally laid it bare, although leaving a great part of it still below the present sea-level. Under these conditions, whenever more water comes down the river than its banks can contain, the silt-formed shores give way to the increased pressure and permit the excess of water to flow to, and gather in, what is termed the river swamp at the back of the flood plain, from whence it either reenters the river lower down in its course, or finds its way into the depression.

The Salton Marsh at present acts as the catchment basin for the waters draining from the east side of the San Jacinto range, Carizoo Creek, and a part of the San Bernardino Mountain range, and in times of extreme high waters as a reservoir for the excess in the Colorado River. In the month of June, 1891, a steady flow of water entered the depression from the southeast and continued to the northwest uninterruptedly until an area 30 miles long and averaging 10 miles in width was covered to a depth of 6 feet, measured at the end of the Salton Salt Works branch track. When first examined the water showed a density of 7° Baumé, which gradually increased to 25° Baumé. The mother liquor used in making salt at the New Liverpool works usually shows a density of 27° Baumé. This salt water gave rise to the idea that the waters from the gulf had made an inroad through some underground channel, and to prove the source and possible permanency of these waters several investigating parties were sent out. No such previous incursion had been witnessed by the settlers, but inquiry proved that a similar lake existed here in 1849. Finally one of the parties showed that the Colorado River was the source, and then the question was brought to the attention of the State Mining Bureau to investigate as to the probability of the permanency of the lake and its probable effect on the climate of the surrounding country.

The Colorado in its great length accumulates a large amount of sediment, from 0.1 to 0.4 per cent per gallon, and after this has been

deposited the water on evaporation is found to contain 0.14 grammes solid residue, consisting largely of sulphate of soda and chloride of sodium. With the sediment the river is all the time building up its flood plain, and it may not be out of place to recall the general laws that govern the actions of streams while depositing the solid matter they carry in suspension.

Currents bearing sediments deposit a large percentage as soon as their velocity is checked in the least, but pick up deposited sediments again as soon as the current is increased. Thus a variable current is depositing at one point while eroding deposits at other points.

The velocity of a river current varies with the seasons on account of the different volumes of water carried, but it also varies at different points of the river, during the different hours of the day, through the constant action of the laws of erosion and deposition. The banks not furnishing a constant, even resistance, erode in the looser parts, causing each time a deflection of the current, as well as a change in the velocity. This action soon changes a straight stream with an even current, to a serpentine course with currents of different velocities, as the outside of a curve has always greater speed than the inside; consequently the outer edge is eroding while the inner is depositing sediment. The Colorado River, in the lower part of its course from Yuma down, overflows its flood plain, and deposits thereon a certain amount of sediment during every high water. This flood plain extends back for several miles on the west bank, showing a succession of benches or levees running parallel with the stream on a higher level than the back country. The water, when high enough to reach over these benches, gathers in the back part, where it evaporates, leaving a mud that greatly enriches the soil. These levees are the result of the law quoted above, as the water in the regular channel flows swifter than on the flood plain; consequently on the border of the two a large amount of sediment is thrown down. As these border lands are only covered during the highest floods, they maintain a growth of willows and poplars that gives the banks a greater stability, and preserves them to a certain extent from the erosive force of the current.

A source of changes in the direction of the main current is the stranding of logs and tree tops brought down from the upper courses of the river, as the sediment accumulates behind them and forms islands in midstream. Several of these are to be seen in the river channel in passing down the stream.

From soundings made across a section of the river at the railroad bridge at Yuma, the depth was found to vary from 2½ feet to 21 feet. At the meter placed in the main channel the indicator showed a depth of 17 feet.

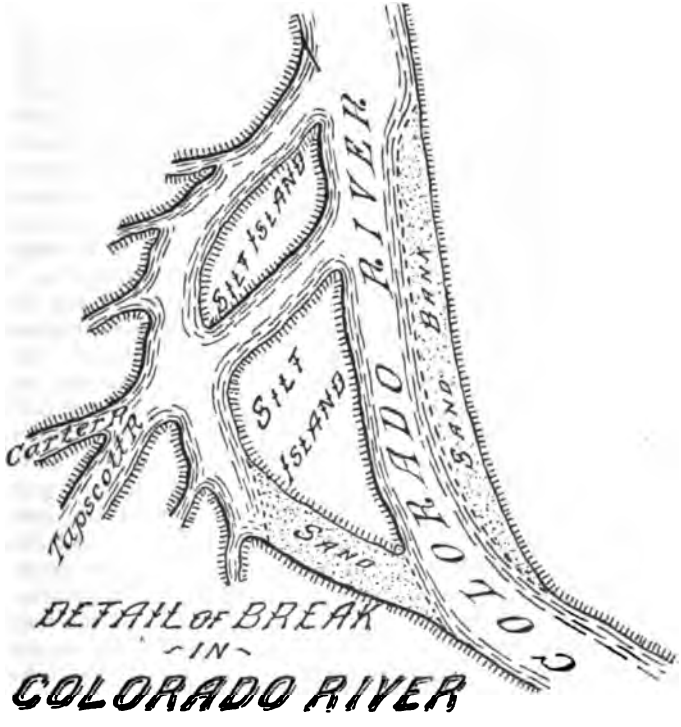
At ordinary high water, caused by the annual rising of the Gila River, or of the Colorado in its upper reaches, which events usually occur at different seasons of the year, the meter has not been known to show a depth of over 28 feet, but in consequence of a co-equal rise in both streams during the past season, the meter registered over 33 feet. This excess filled the river swamp on the right bank, where the erosive force of the current was most effective.

The course of the river below Yuma for several miles is to the west, until the neighborhood of El Rio station is reached, where sandstone bluffs on the right bank deflect the current back to its general south

SECTION OF COLORADO RIVER AT YUMA

course. A little back from the river below this point is a small, isolated range of hills, known as Pilot Knob, formed of granite, fissured with seams of dioritic rock. The granite shows lamination, and the surface of the rocks is polished by the constant attrition of the drifting sands. The beach near Pilot Knob is cemented into a calcareous conglomerate, underlaid by sand in a loose state. After resuming its southern course the river for several miles follows a straight reach, until below Hanlon's Ferry. The tendency of the current to bear more to the right bank shows itself now in the formation of sloughs and inlets that absorb a large proportion of the water and form several islands, shallowing that part of the river that passes down the proper channel.

The accompanying sketch shows the different channels in detail. Formerly the water from these outside channels returned through the



bend marked "sand" to the main stream, but at the present time it passes through a crevasse in the bend, marked Tapscott and Carter Rivers, furnishing the largest portion of the water that ultimately found its way into the depression of Salton Lake. During the extreme high water the western bank from El Rio down, which is formed entirely of

silt, was broken through in numerous places, and the mostly shallow channels either entered the river again below, or accumulated their waters on the back part of the flood plain, and by following the natural hollows and gullies gradually wound their way in the direction of the old Yuma road. The great force of the current soon cut down below the level of the river bed and relieved in part the congested condition. The grade being gradually to the west, the water cut through the sediment in that direction, partly to the Yuma road, partly farther south parallel to the Rio El Medio, which, judging from analogy, owes its origin to some former similar condition of the river.

Tapscott River may have been formed prior to Carter River, as it has a better defined channel; the latter has no regular channel, but seems to have been caused by the excess of water that could not enter the former, following depressions and sloughs which have no direct connection with one another. At the time these observations were made, the estimated volume of water in the river at the Yuma bridge was about 3,700 cubic feet per second, and at the crevasse forming Tapscott and Carter Rivers, two fifths of the entire volume of water in the river was passing through, but none of it was reaching Salton Lake. Of this two fifths not more than 20 cubic feet per second was running through Carter River.

Beyond Alamo Mocho, which is on the old Yuma road, at the time of the flood, the water flowed into a number of lagoons, and thence into New River, following the old channel that was cut at the time of the 1849 overflow, and thus reaching and forming Salton Lake. All of the water leaving the main river at present finds its way down through the Hardy Colorado back to the Colorado proper, or evaporates.

In the beginning of this article mention was made of a borehole that was sunk by the new Liverpool Salt Company in the salt marsh, and which revealed under a thin crust of mud and salt a depression filled with ooze, composed largely of magnesium and sodium salts. This ooze is probably the final resultant of the evaporations of the former sea water, and which, from the well-known avidity of the magnesian salts for moisture, is kept in this condition of ooze through the natural drainage and seepage waters. This depression may extend beyond the borders of the present marsh toward the gulf, covered over by the sand, and may have some relation with the small so-called mud volcanoes southeast of the lake near the station of Volcano, as well as with some openings in the ground mentioned by one of the gentlemen who investigated these regions between the Colorado River and the lake, and of which he stated that any amount of water running into them did not seem to fill them. Should such a connection exist, the water pouring in from the river would have dissolved the thin salt crust where exposed, and opened a channel, permitting a rapid filling in of the water which formed the lake, for otherwise a body of water running over this light sand and under such a dry, hot temperature would hardly have filled up the depression as rapidly as was the case. Besides, this would explain the reason for the fresh waters of the Colorado River attaining so rapidly a density of over 20° Baumé. Should this supposition prove correct, and it could easily be ascertained by a series of shallow boreholes, it might be expected that every large overflow in the Colorado River in this direction would result in a repetition of Salton Lake.

To avoid any such contingency it would require but little correction of

the banks of the river. By the aid of a few jetties placed on the right bank above the silt islands as marked in the drawing, the current can be made to scour out the sandbar in the main bed that has formed on the left bank, and at the same time silt up the channel between the islands, thus leaving the crevasse quite a distance from the river, with the intervening space well filled in. This part of the river being Mexican territory, the coöperation of that government would be necessary.

As large areas of this depressed ground in the Coahuila Valley are extremely fertile when brought under the influence of water, it is a pity that this annual surplus could not be brought onto part of it through American territory; but from investigations made by United States officers years ago, it was found that such an undertaking was impracticable without tunneling for quite a distance. From a point near the break, on Mexican ground, surveys have, however, proved its feasibility.

As the lake is fast disappearing, and will only be intermittent, it is not necessary to enter into the possible or probable effects on the climate of the surrounding country. One thing is certain, however, that a large, permanent body of water filling the depression would make this section of the country more habitable.

SAN JOAQUIN COUNTY.

By W. L. Watts, Assistant in the Field.

THE STOCKTON TERRA COTTA COMPANY.

This company was organized in 1891, when they erected their works at Stockton. Their plant consists of three round down-draught kilns, each of which has a diameter of 20 feet in the clear, together with the necessary machinery for the manufacture of drain and sewer pipe and general terra cotta ware. They obtain their clay from Valley Springs, in Calaveras County.

THE SAN JOAQUIN BRICK COMPANY.

This company, which was organized in 1891, at Stockton, is now operating the brick yards formerly owned by the San Joaquin Improvement Company. They have erected one Hoffman continuous kiln, having a capacity of 235,000 bricks every twelve days. This kiln is used for common brick, some of which are machine and some hand-made. The fuel used is the screenings of Wellington coal.

One circular down-draught kiln is also employed, which has a capacity of from 30,000 to 35,000 bricks per week; this is principally used for stock brick and some pressed brick. The clay is dug by a steam dredge manufactured by the Marion Shovel Company. The material brought up by the dredge generally contains sufficient sand.

NATURAL GAS.

The investigations made by the writer in connection with the natural gas of San Joaquin County are too lengthy to be included within the prescribed limits of this report.

SHASTA COUNTY.

By Dr. Wm. G. Hodson, Assistant in the Field.

Shasta was among the first counties that attracted the attention of the early gold seekers. The exceeding richness of many gulches made a combined total of millions; these have been partly worked out, and the attention of prospectors has been mainly drawn of late to the rich croppings of gold and silver ore that intersect her hills and mountains.

On the east side of the Sacramento River there has been much prospecting done during the last twelve months. Rich Gulch, about 5 miles north of Redding, the county seat, runs through a belt of country northeast to southwest, that is covered by productive mines and promising claims. This is known as the Churntown and Old Diggings Districts.

Mr. Hart, of the Texas and Georgia Mine, has driven new tunnels and opened up a rich vein that will add largely to the value of that property. Other mines in the immediate neighborhood, the Mammoth, the Calumet, and the Walker Bros., are all pushing new tunnels vigorously; the ore is in great quantities, and assays $40 per ton all round. The Reid Mine has lately changed hands, and a new tunnel is being driven.

At the Calumet, Mr. Almarin B. Paul has a good showing. This gentleman's experiments with the cyanide process are promising very satisfactory results. His plant has been considerably increased and the latest tests yield 92 per cent. The base ores in Shasta County are almost all amenable to the new process, and much encouragement has been given to the poorer class of locators, and their name is legion, who have good claims with well-defined ledges.

The latest developments on Rich Gulch are in the Churntown District, northeast of Old Diggings. Colonel Lyons has lately opened up a fine property; five tunnels have been driven, and in every instance the ore on the dumps shows a large percentage of free gold, sulphurets, and silver. George Forbes' claim is south of the Lyons group; his tunnel runs in 400 feet, and the ore assays $50 per ton. There is a small Huntington mill on the property. These veins run northeast and southwest, dip westerly into the mountain, and the foot wall is slate, with trap rock for a hanging wall. A little farther northeast Judge Simons has a most promising prospect.

On the west side of the Sacramento River are situated some of the best known mines of Shasta County. Between here and the Sacramento River the Spring Creek and Flat Creek mines are making good showings. New finds are reported almost every week, particularly in Sec. 7, T. 32 N., R. 5 W. Some miles north is Squaw Creek District, in which is situated the Uncle Sam and other well-known mines. During the past year they have been more than holding their own.

A comparatively new district is the Muletown, situated 7 miles west

of Redding, in T. 31 N., R. 5 W. The veins lie in a porphyry and slate formation, and the croppings in the Midnight Mine on Muletown Mountain run for the distance of four claims; the ore is full of sulphurets, and is interspersed with seams of ochre, the latter assaying as high as $140 in gold per ton. There are two parallel veins about 50 feet apart, and running northeast and southwest; the dip is westerly, but rapidly becomes perpendicular.

In the Igo and Ono Districts, that lie farther west, there has been much work done during the past year. The present outlook is very good; a large number of new mines have been added to the old list. Messrs. Yount & Co. are at present erecting works for the reduction of the silver ores of this district.

Farther west is a large body of rich ore in the Sunny Hill District. The property is owned by Judge Aaron Bell and his brother, Joseph Bell. The ore sent by them yields $250 per ton in gold. It is an ochre ore, which, while not attractive to the inexperienced, has a facility for making attractive returns. There are many good claims in this district, and the bodies of ore promise to hold out well.

Indications of extensive deposits of lead have lately been found in the Round Mountain country, and prospecting is being vigorously done, notably by the Bell Brothers.

From the Stillwater District there has been lately shipped a carload of iron ore to the Pacific Rolling Mills. This ore carries 72 per cent of iron. It comes from a large mineral belt that is cut by the Sacramento, Pitt, and McCloud Rivers. It crosses the Sacramento at Kennet, crops up in an easterly direction at the fishery on the McCloud River, continuing to Copper City and beyond. Near Bass Post Office, on Stillwater, T. 33 N., R. 4 W., there have been some tunnels driven. Magnetic iron, chrome iron, and manganese are found in this lime belt at all parts so far as examined. Carbonate of copper is found in large quantities farther east.

In the eastern portion of the county is also a large coal-bearing region, as yet untouched; the coal is bituminous, but owing to the immense quantities of wood and charcoal in the county the fields have been allowed to remain idle.

TEXAS CONSOLIDATED MINES AND MILL.

During the year 1892 considerable encouragement has been given to Mr. R. G. Hart, Sr., by the large showing of ore in his Texas Mine, Old Diggings District.

The tunnel last driven was commenced in June, 1890, and has been run in for 800 feet. The direction is 18° east of north. The vein shows 11 feet 6 inches from wall to wall. The tunnel follows closely the direction of the vein, and was driven for 300 feet between the plainly marked porphyry walls, that were filled with clay and disintegrated rock, before the vein was struck, the ore realizing from $40 to $60 per ton.

Tunnel No. 3 has been driven on the same vein for 1,100 feet, and is 105 feet above No. 4. The vein is well defined. Tunnel No. 2 is in 380 feet, 120 feet above No. 3, the walls and vein showing well. Tunnel No. 1 is in 300 feet on the same vein. This vein widens steadily as it goes down, and the quality of the ore continues the same. There are three

parallel veins. A wire cable is used for the transmission of ore from the mine to the mill; the latter is situated on the Sacramento River. Twenty stamps are continually running, with eight concentrators, with Morris tables to catch the slimes. Roads, plant, and tramway have cost $100,000; driving tunnels, etc., $130,000.

MAMMOTH MINE.

Closely adjoining the Texas Consolidated on the east side is the Mammoth Mine. Tunnel No. 2, 230 feet below the surface, is 900 feet long and runs in a direction 11° east of north. It has been driven along the vein, the walls being well defined. There is an upraise, 300 feet long, to tunnel No. 1. For the first 300 feet the vein is 17 feet 6 inches wide; for the second 300 feet it averages 14 feet, and for the last 300 feet it is 37 feet in width. A new tunnel is about to be driven 589 feet from the surface, and it will be 2,000 feet long, following the vein nearly all the way. The vein in the upper tunnel is 23 feet wide, and basing calculations upon this the lowest tunnel will develop over 4,000 tons of ore.

The Garfield Mine is owned by the same company, and adjoins the Mammoth on the east side. The vein is 12 feet wide. The ore from both mines yields $40 per ton.

WALKER BROTHERS' MINE.

In the same district is the Walker Bros.' Mine. The vein runs slightly east of north, and contains a very large body of ore. A new tunnel is being driven over 300 feet from the surface, nearly parallel with the vein, which latter it will strike when in 310 feet. By running the tunnel in this manner Mr. Ripetto, the Superintendent, hopes to have the workings clear of water. The tunnel is 500 feet from the surface, and the cost of hoisting, etc., will be avoided. The two upper tunnels have opened up an immense body of ore 50 feet wide with good walls. The ore runs high in sulphurets, and it is the intention of the owners to work it by the cyanide process.

STELLA.

Whiskytown, now named Stella, is 7 miles north of the town of Shasta; the French Gulch toll road passes through it.

The Banghart Mine is now owned by George Grotefend and James Eligh. This mine consists of rich seams in a porphyritic formation, 200 feet from wall to wall. The main tunnel is 1,400 feet long. There have been altogether twenty-one tunnels driven. The ore contains free-milling gold and sulphurets, and is worked for the free gold alone. As much as $500 has been taken out of a rich seam in one day; during the three weeks previous to my visit $3,000 had been taken out.

On Spring Gulch, Messrs. Flemming & Wool are opening up a good property. The tunnel has been driven 200 feet, and is 75 feet below the surface. The vein is variable in width, from 2 to 6 feet. The ore yielded $40 per ton when crushed in the mill (ten-stamp) at the Mad Ox Mine.

The Mad Ox has lately resumed work. Louis Reil and Jos. Wool are

the owners. The tunnel is in 1,400 feet, and taps the ledge 700 feet below the surface. The ore goes from $30 to $40 per ton.

On Grizzly Gulch there has been some prospecting done during the past year, with promising results.

John Bradbury, Warfield & Hathaway, and C. R. Nalson have been doing some work on their claims. Mr. Bradbury has driven his tunnel 150 feet, shaft 75 feet; the vein is in slate and porphyry, and is about 3 feet wide, carrying $40 rock.

DON CARLOS MINE.

This mine is located in Flat Creek District. Charles Thistlethwaite is part owner and manager. The new tunnel is at the east side of the ledge, and will cut the shaft at a vertical depth of 103 feet. The first tunnel, from which high assays were made, crosscuts the ledge at 102 feet; shaft 44 feet deep.

UNCLE SAM MINE.

This mine, which is located in Squaw Creek District, is owned and worked by the Sierra Buttes Company. It lies south of the Snyder group, in the same mountain. The lode runs north and south. The lower tunnel is 1,200 feet long, crosscutting the vein at this distance; it then follows the vein in an easterly direction for 800 feet, and in a westerly direction for 500 feet. The width of the vein varies, being an average thickness of 10 feet, and 15 feet at the largest bulge. The ore contains free gold and sulphurets. There are two upraises 400 feet long, and another is being vigorously pushed from the west side. The height from lower tunnel to the summit is 550 feet. There is a raise of 300 feet more at the apex of the mountain, the croppings showing all the way and prospecting well. Level No. 2 is 1,200 feet long, and is 300 feet from the summit, the vein showing strong and the stopes numerous and wide. In level No. 1 the vein is 2 feet wide, and rich returns have been had from it. Four Burleigh drills are in use. There are tramway connections between the levels and the mill. The latter is a thirty-stamp with plates and twelve concentrators, six Triumph and six Frue vanners. Steam power is used, and lumber is brought across the creek by a wire ropeway from a timber section that has been secured by the company. The mill is kept running steadily. Sulphurets, 1 to 2 per cent. averaging $150 per ton. A chlorination plant adjoins the mill.

Everything about this camp is in perfect working order; accommodations for the men excellent, roadways well graded, and site for a mining camp all that could be desired.

RILEY & BLISS MINE.

Messrs. Conroy, Weil & Hume have started to work on this mine, and everything is in good running order. The No. 2 tunnel is now in 800 feet, and there is a fine breast of rock in sight 20 feet wide. This tunnel is 850 feet below the summit and over 1,000 feet below the apex of the mountain. It is proposed to drive another tunnel 300 feet lower down.

Tunnel No. 1, 650 feet below the summit, is 800 feet long, and the vein is 12 feet wide. Stoping has been done for 125 feet, and is 40 feet high. There are two upraises from the lower tunnel.

The rock is a ribbon, carrying $5 per ton in free gold, and averaging 1½ per cent in sulphurets that go $150 to the ton. The present mill is a ten-stamp, and the ore is chiefly worked for the free gold that it contains. There is plenty of water; it is brought in an 11-inch pipe from the South Fork of Squaw Creek. This is in addition to the water that runs in the North Fork. The present mill is run by water power taken from the 11-inch pipe. There is a group of claims adjoining, that are owned by the present company, also timber claims across the creek. The distance from Kennet is 7 miles.

THE SNYDER GROUP OF MINES.

This consolidated group of mines, situated in Squaw Creek District, consists of a number of claims, and three well-developed mines, as follows:

The Clipper vein runs south of east and north of west for 1,500 feet. The pitch of the vein is 45°. The pay shoot is 230 feet long, the vein averaging from 5 to 7 feet in width, 5 in the upper tunnels and 7 in the lower, No. 3. From the latter tunnel to the summit is 100 feet; to apex 350 feet. The vein shows strong and is of very even quality, with well-defined walls. The ore is easily worked; it can be taken out and milled for $3 per ton. Its value is, in free gold, from $10 to $12 per ton; in sulphurets, $5 to $8 per ton. Cars holding 1½ tons each and drawn by a mule on a well-constructed tramway, convey the ore to a point immediately above the mill. It is dumped into a 200-ton bin and a wire rope-way bears it down to the mill. There is storage capacity for 150 tons at the mill, and also at the mine. This allows a large reserve of ore when dead work is being done in the mine.

The Crœsus lies between the Clipper and the Snyder Mines. The veins are parallel. The tunnel in this mine is 500 feet long, and taps the vein at 350 feet. The latter averages from 5 to 7 feet wide, and mills from $5 to $10 per ton. The claim is 3,000 feet long, and the tunnel is 500 feet below the summit of the hill.

The Snyder vein averages 3 feet wide, and the ore mills $8 per ton. The lower tunnel, No. 3, is over 500 feet below the summit of the hill and follows the vein for 360 feet. This vein crops out over the hill for 2,000 feet. The pitch of the vein is 45°. These mines are 2,600 feet above sea-level. A T railroad 1,800 feet long connects these mines with the rope-way.

A ten-stamp mill is kept running night and day. There is water power for from six to seven months in the year; during the remaining months steam power is resorted to.

The concentrators are of Mr. Barron's own design, and have proved very successful. It is in contemplation to put up twenty more stamps, also an additional number of concentrators with canvas tables. The present daily run yields $150 in free gold, independent of sulphurets. The free gold is not so fine as that generally found in the quartz of this county. It is all caught on the plates. The sulphurets run from 2 to 2½ per cent, equal to $500 per ton. There is plenty of good timber, and every advantage has been taken of a position that is one of the best in the county for a mining camp. Seven miles of good toll road connect the mines with Kennet, a station on the California and Oregon Railroad.

SIERRA COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

This may be termed an exclusively mining county, as its agricultural interests are but small, the area comprising mostly mountains, with narrow cañons. As in Plumas, mining has suffered almost to the extent of extinguishment, through the shutting down of its hydraulic mines.

The main streams, which are coincident with the chief mining centers, are, commencing on the northwest: Slate Creek, which, for quite a distance, forms the boundary line between Plumas and this county; then Cañon Creek; the North Yuba River, which flows nearly through the center of the county; Oregon Creek; and the Middle Yuba River, which forms the dividing line between this county and Nevada County. All of these streams flow from northeast to southwest, and the banks of all of them have been productive in gold. More than six peaks in the county attain a height of 7,000 feet and above; these are:

Table Rock Mountain	7,000 feet.
Alturas Mountain	7,900 feet.
Four Hills Mountain	7,200 feet.
Sierra Buttes	8,300 feet.
Bald Mountain	7,690 feet.
Webber Peak	7,780 feet.

To give an idea of the general high altitude of the country, the following figures are given of points in the county and near the line in Plumas:

La Porte	5,000 feet.
Bald Mountain, adjoining La Porte	5,916 feet.
Rabbit Creek bridge	4,200 feet.
St. Louis	4,900 feet.
Howland Flats	5,500 feet.
Divide between Slate and Cañon Creeks	5,600 feet.
Pilot Peak	7,505 feet.
Onion Valley	7,263 feet.
Mohawk Valley Hotel	4,325 feet.
Divide between Sierra and Mohawk Valleys	5,225 feet.
Divide between Sierra Valley and east branch of the North Fork of the Yuba	6,275 feet.
Bridge over Sardine Creek at foot of Sierra Buttes	5,750 feet.

In the northern part of the county, between Mohawk and the Sierra Valley, the country rock is syenitic granite, also around Sierra Valley. The granite extends to within about 6 miles of the Sierra Buttes, near the Bassett sawmill; at the latter place Howard Creek empties into the South Fork of the North Yuba. Passing up this creek a distance of 5 miles several claims in the bed of the creek were noticed.

THE ADELAIDE MINE.

This mine is in the Gold Lake Mining District. It contains three locations, and purposes to work a contact vein between the granite of the Haskell Peak ridge and the clay slate. The vein averages 5 feet in

width, and courses 15° west of north, dipping at an angle of 45°. The works consist of two tunnels running across the slate. No. 1 is 60 feet to the ledge, from where a drift runs 35 feet to the south and 25 feet north, giving a vertical depth of 30 feet. No. 2 is in 200 feet, with 300 feet more to run to strike the ledge; this will give a vertical depth of 225 feet. At present two men are driving this lower tunnel ahead. By mill process the quartz has been worked up to $10 50 per ton. No stoping has been done. The company control a water right from springs which can be brought onto the ground under a pressure of 500 feet.

BULL OF THE WOODS MINE

Is situated on the contact north of the above. The vein on this location shows a width of 30 feet. A 40-foot shaft has been sunk and a drift started from the bottom, which has been driven about 25 feet. The vein is broken up. Four men are at work putting the drift ahead. The quartz from this part of the vein pays from $4 to $5 by mill process.

HAYES & STEELMAN MINE.

In close proximity to the above, but situated just below the contact, is the hydraulic claim of Hayes & Steelman, containing 25 acres.

The claim is covered with timber. The bank varies from 3 to 70 feet in depth, averaging about 7 feet. The gravel is not a true wash, but more in the nature of a slide. The slate bedrock is traversed by a hornblende dike 300 yards in width. The claim is entirely dependent on snow for the water supply, the water season averaging about three months, during which time they employ about ten men. The gold obtained is largely quartz gold .920 fine, which sells for $19 an ounce.

Another small mine working on the contact vein is the

GOLD LAKE MINE,

With a tunnel 750 feet long; it will require 400 feet more drifting before the vein will be reached, which it will cut at a depth of 200 feet.

THE YOUNG AMERICA MINE

Is doing prospect work connecting the lower tunnels through an upraise, while half the mill is being run on low-grade ore. They are working ninety men. The surroundings of this mine, which lies on the north of the Sierra Buttes, give excellent illustrations of the polishing effects of a glacier, on the sides and bed in its downward progress. These polished rocks, surfaces, and grooves are very distinct for a distance of 1½ miles down what was the former bed of this ice river. Near the main serrated ridge two beds are discernible that unite lower down and form one body where at present the two Sardine Lakes are seen. The cañon through which the drainage from the lakes finds its way to the Yuba River is lined, more especially on the north side, by the remains of a moraine; the bowlders of the end moraine may likewise be distinguished.

SIERRA BUTTES MINE.

Across the main ridge from the Young America Mine is the Sierra Buttes Mine, at present working a crew of twenty men on the croppings and reserves in the upper works around No. 1 and No. 2 tunnels. They have taken ten stamps from the big mill at the mouth of No. 9 tunnel and erected a mill near No. 2 tunnel. The mine has been working on several veins in close proximity to one another on the south side of the ridge adjoining the town of Sierra City. These veins in their strike gradually approach, until they come together on the top of a ridge that runs down from the main backbone, after crossing which they again diverge. On the Saddle-back ledge, which crosses the main peak, running nearly parallel with the main Sierra Buttes Mine vein, three men are at present prospecting, with favorable prospects. Likewise immediately back of the town, two men are prospecting on a claim called the "Sunnyside," an extension of the Sierra Buttes vein, known as the "Whisky"; they have driven, in fifteen months, 150 feet of tunnels and connected the two tunnels by two upraises. The course of the vein is northwest and southeast. At the present time a test run is being prepared to be made in the No. 9, Sierra Buttes mill.

THE PHŒNIX MINE

Is also on the south side of the Sierra Buttes Ridge, and has, during the past season, built a good ten-stamp mill in the cañon at the foot of the hill just below the mine, to which the ore is conveyed by rope tramway. This method of delivering the ore from the mine to the mill is largely applied throughout this neighborhood. At the present time the mine and mill are running, with favorable results. The power for the mill can supply 600 inches of water under 485 feet of pressure.

THE MOUNTAIN LEDGE MINE,

On the east end of the Sierra Buttes Ridge, has a finely arranged forty-stamp mill adjacent to the stage road to Sierraville; the ore is delivered to the mill from the mine above by tramway. For a time trouble was experienced in making this tramway, which is self-dumping, work successfully; the weight, when put on the rope, cut and broke it. By greatly reducing the capacity of the rope, from 80 tons to 30 tons a day, it works all right. In the early part of the season the mill was not running. At present lessees are running both mine and mill.

THE CHIPS MINE

Has kept its twelve-stamp mill running, and has been pushing ahead as fast as possible the upraise that is to connect the two tunnels. So far all the work on this mine has been expended in work on one short pay chimney not 30 feet in length. The expense of drifting is greatly increased by a dike of extremely hard rock intervening between the slates.

There are at the present time around Sierra City the following number of stamps:

Sierra Buttes, at No. 2 tunnel	10 stamps.
Sierra Buttes, at No. 9 tunnel	20 stamps.
Marguerite Mine	20 stamps.
Colombo Mine	10 stamps.
Chips Mine	12 stamps.
Phœnix Mine	10 stamps.
Young America Mine	40 stamps.
Berger Mine	10 stamps.
Mountain Ledge Mine	40 stamps.
William Tell Mine	3 stamps.
Keystone Mine	20 stamps.
Total	195 stamps.

In passing down the cañon of the Yuba, just beyond the town of Sierra City, a belt of serpentine coursing northwest and southeast and about half a mile wide crosses the road and passes beyond the river. Near the contact of this serpentine belt, on the southeast side of the Sierra Buttes Ridge, is the Colombo group of claims, now being worked by tributers. It was thoroughly described in the report of 1890. Like so many of the surrounding mines, it makes use of a gravitation tramway to convey the ore from the mine to the mill, which it does at a cost of 6 cents to the ton. Below this group, running on the same general course as the serpentine, is a limestone belt, which can be traced across the river. The Marguerite group, near Logansville, has, during the past season, resumed operation; the ditches and flumes have been thoroughly repaired, and the mine, which has been full of water, is being pumped out, in view of active mining operations to be inaugurated. The vein runs under the Yuba River for about 400 feet, causing considerable difficulty in contending with the water, but it is hoped now that no further hinderances to the work will be encountered.

MARTINE AND KEYSTONE MINES.

A trail leads up the ridge on the left bank of the river to the Martine and Keystone Mines, whose veins course northeast and southwest; the former shows in the workings an average width of from 3 to 4 feet, the latter from 1 to 2 feet, but swelling out in places to a very considerable width. Financial complications caused the works to be shut down, but lately they have been leased to parties who are arranging for active work. This property has yielded a high grade of quartz. The Martine vein can be traced for a distance on the opposite side of the river, being, however, in places covered over by the slate bedrock. A large section of the hillside where the mill and cabins stood has slid out, leaving a large basin.

Altitude of bridge over South Fork of North Yuba at Logansville, near Marguerite Mine	3,920 feet.
Crossing of the Keystone trail over the upper ditch of the Marguerite property	4,350 feet.
Lower tunnel of Keystone Mine	5,500 feet.
Lower tunnel of Martine vein	5,820 feet.
Upper tunnel of Martine vein	5,950 feet.
Highest croppings of Keystone vein	6,125 feet.
Ditch of Martine claim	4,075 feet.

At Logansville, 3 miles below Sierra City, on the left bank of the river, a bench of gravel extends for a quarter of a mile down the river at an elevation of 50 feet above the present channel, over slate bedrock. The bowlders consist of granitic, porphyritic, and hornblende rocks; the

grade of the channel is flatter than in the present river bed. This bench has been worked nearly the entire distance. Passing down the river several Chinese river diggings are passed.

KANAKA MINE.

About half way between Sierra City and Downieville, on Kanaka Ravine, is the old Kanaka Mine, working on a quartz vein running nearly due north and south, pitching slightly to the east, averaging 3 feet wide, although swelling to large proportions in places. It has been opened by two tunnels; the lower one has been carried forward a distance of 400 feet to the vein, which it cuts under a sharp angle, about 15°. The vein has been drifted on 200 feet. The walls are black slate and quartz schist. A shaft 208 feet deep connects with the surface, double compartment, 3 by 5 feet; it has been continued 20 feet below the level. The upper tunnel is 32 feet above the main one, but is not used. The ore is highly sulphuretted, containing sulphides of iron, galena, zinc, etc.; near the surface the quartz showed free gold. The sulphurets yield $10 a ton by mill process. Lower down no gold could be obtained in the mill out of the ore.

In Jim Crows Ravine, which empties into the South Fork of the North Yuba from the south, is

THE COMET MINE.

The vein courses northwest; the hanging wall is slate, the foot wall porphyry; it dips to the west 40°. A crosscut 175 feet long strikes a 3-foot vein; about 80 feet back, a vein about 10 feet wide was crossed; a third vein has not been reached yet. From the back of the tunnel to the surface is a vertical depth of 87 feet. The five-stamp mill has 750-pound stamps. The quartz is stated to contain 5 per cent sulphurets, mostly iron and copper sulphides. The ore is said to yield about $8 per ton by mill process. About 6 inches of water drains from the tunnel. Seven men are employed at the mine.

The county seat, Downieville, at an altitude of 3,060 feet, is surrounded on all sides by high mountain ridges forming the cañons of the North Fork and South Fork of the North Yuba River, which unite here. North of the town is a serpentine belt crossing Serpentine Hill; altitude, 4,450 feet. This is presumably a branch of the serpentine that passes through Plumas and enters Sierra County at the foot of Pilot Peak. The town has been the center of extensive river mining in former days, the bars having yielded extensively.

Passing up the road along the East Fork of the North Yuba a short distance above the town is the Gold Bluff Quartz Mine and mill, lately sold to an Eastern company, who are putting up a new plant.

Passing on up the North Fork of the Yuba through a slate country, deeply cut down by the river, whose bed has been worked nearly the whole distance, and is still being gleaned over by Chinese companies, the trail crosses a divide leading on between the East Fork and Middle Fork. West of this point, at an altitude of 5,040 feet, on the divide between the North Fork of the North Fork and Middle Fork, is

THE WIDEAWAKE DRIFT MINE.

They are drifting for a channel running northwest and southeast through a slate country. The tunnel has reached the channel after driving 900 feet, at a vertical depth of 300 feet below the surface. The channel is lava capped and contains considerable pipe clay; the gravel is free and contains coarse gold, about $2 per carload. Five carloads a day to the man is the usual output. Twelve men are employed at $50 per month and board. On the opposite side of the ridge from this mine, running for the same channel, is the Germania Drift Mine, with a 600-foot tunnel. They have not yet reached the gravel, and are waiting for the other company to develop the direction and width.

Proceeding on the trail across another divide, Gold Valley is crossed, a large part of which is in diabase. Several mines and prospects are being developed here on both sides of the valley, although but little active work is in progress. The Garibaldi with a ten-stamp mill and the Lone Star, both on the east side, as also the Willoughby Mine with a ten-stamp mill on the west side, and the Empire Mine are idle, the Willoughby on account of litigation.

THE LONE STAR MINE,

At an altitude of 6,750 feet, lies about 14 miles northeast of Downieville. The company are operating on a northwest and southeast vein averaging 4 feet in width, dipping at an angle of 75°. The hanging wall is diabase, the foot wall slate. A tunnel 400 feet in length has been run for the ledge, requiring about 150 feet more to run. The shaft is 20 feet deep. The quartz is similar to that of the Young America. After passing through this valley the trail ascends to the southeast end of Gold Lake over a rough country; the altitude here is about 7,000 feet. Large masses of quartz crop out along the ridges that skirt the shore of the lake, coursing about 15° west of north.

TRUE FISSURE CONSOLIDATED MINE.

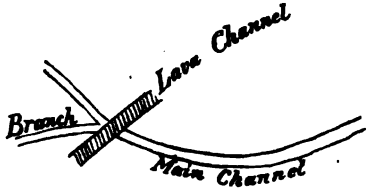
The group of claims located here in close proximity to the lake on Secs. 19 and 30, T. 21 N., R. 12 E., comprise the Fissure, the Cavern, the Deer, the Gold Lake, the Summit, and the Pigeon Egg. The labor performed consists of a shaft 60 feet deep, a tunnel 400 feet, and a second shaft 25 feet deep. On the Gold Lake ledge is a 50-foot tunnel, besides numerous surface openings and cuts; the veins are nearly perpendicular, averaging from 6 to 8 feet in width. The quartz is well mineralized. From the course of the veins and the formation of the country these veins and those of the Sierra Buttes mines may belong to one and the same system. There is an abundance of timber of the best quality, and the lake supplies all demands for water. The shafts have cost $20 a foot to sink; the tunnel was driven for $7 a foot. The 400-foot tunnel passed through six separate quartz seams, but has not as yet reached the vein run for; it is now 102 feet beneath the surface. The 50-foot tunnel runs on the Gold Lake vein. The 60-foot shaft has about 6 inches of water running in. Only a few men are employed here at present.

Crossing the junction at Downieville and taking the trail south,

known as the Forest City trail, the ascent commences right from the river bank flanking the east side of Slug Ravine, famous in early days for the coarse gold found, and continues upward about 4 miles, to the summit, at the City of Six. Most of the ascent is made over a slate bedrock, with the regular northwest and southeast course; only shortly before reaching the head of the ravine a narrow intrusion of serpentine is crossed, which, from its course, would appear to be a branch of the serpentine encountered later in the neighborhood of Goodyear Bar. The City of Six is at the edge of a lava plateau, across which the trail passes to Bald Mountain and the adjacent mines.

RUBY GOLD GRAVEL MINE.

This mine was located in 1865, and was bought by the present company in 1871. It controls 2 miles of channel, and is situated about 2½ miles from Forest City. There are three different channels in this claim, one of which is a lava bowlder channel.



The capping consists of 800 feet of lava over 4 feet of gravel. The course of the main channel is 15° northwest. The difference between the elevation of top of deposit and the underlying bedrock is something over 800 feet. The altitude of the bedrock is 7,500 feet. Clay slate forms the channel bed. There are several miles of tunneling in this claim. The channel drifts are carried 150 feet wide and the gravel drifts are 4 feet wide. The percentage of cobbles and bowlders in the gravel, which is free, amounts to 60 per cent. The thirty men that are employed break 70 carloads of gravel per shift, weighing a long ton each. The gold is valued at $17 75 per ounce. There have been 1,800 feet of channel worked in length and 125 feet across. The best pay is found on and under the bedrock.

From this mine the road passes across a basaltic plateau over to Forest City on the other side. It is in the vicinity of this town that the old Bald Mountain claim is situated, one of the most notable of the drift mines in its former days; it is now pretty well worked out. Lessees are taking out some of the old pillars near the front part of the mine. Across the hill from Forest City is the town of Alleghany, nearly on the same altitude, there being only a difference of 40 feet. In former days they were connected by a tunnel through the ridge. The formation on the Alleghany side is slate and serpentine, and there are several gravel and quartz mines in the neighborhood; the latter are largely pocket mines, containing very coarse gold. The altitude of the divide between Forest City and Alleghany is 5,300 feet.

The following mines are situated in the Forest City and Alleghany Mining Districts:

THE SOUTH FORK GRAVEL COMPANY,

Working on the lava channel that cuts through the Bald Mountain channel. The location is half a mile from Forest City; the tunnel is 2,500 feet long to the channel. The gravel averages 14 feet in depth, with lava immediately on top; it contains some gold, but not in sufficiently profitable quantities. From the slate bedrock to the top of the ridge is 750 feet. The ventilation is secured by 2,000 feet of airway, and from there to the breast of the tunnel boxes. The men are working here on two shifts. The tunnel costs $2 50 per foot to drive, the company furnishing the timbers. The wages are $3 per day. A former company run 2,000 feet of tunnel and then sunk a shaft 46 feet into rich gravel, and it is this body of rich gravel and the shaft that the present parties are aiming to reach. Water for washing is obtained partly from springs, partly from Oregon Creek.

THE YOUNG AMERICA, FOREST CITY,

Own 250 acres of ground, and are running a prospect tunnel, now in 400 feet. The ground is situated in Secs. 28 and 33, T. 19 N., R. 10 E. It is thought the tunnel will have to be run 1,200 feet more. Altitude of Forest City, 5,550 feet; altitude of top of ridge, 6,200 feet; altitude of bedrock in tunnel, 5,589 feet.

A shaft has been sunk in Wet Ravine, toward which the tunnel is directed; this shaft is 190 feet deep, and the bottom of the shaft is 5 feet higher than the tunnel will be when it reaches that point. Operations are temporarily suspended, but will be resumed very shortly. The capping is lava; the 3 feet of gravel next to the slate bedrock constitutes the pay. Fifty per cent of the gravel is cobbles and bowlders. Water for washing is obtained from Oregon Creek.

The following claims are all in the Alleghany Mining District:

OSCEOLA QUARTZ MINE.

Located in 1884. The vein courses northwest and southeast, dipping 50°. The hanging wall is talcose slate; the vein is 4 feet wide; a pocket mine; the quartz contains a little pyrites and galena. It has been opened by two tunnels 200 feet apart. A small prospecting mill belongs to the property.

THE RAINBOW GOLD MINING COMPANY

Embraces three locations. Strike of the vein northwest and southeast, dips 50°, with the same walls as above; also a pocket vein, the average of the quartz paying only $2 50 per ton. The vein is 3 feet wide. Two tunnels 400 feet apart, connected by a winze, constitute the developments; 200 feet in length has been stoped. In the pockets the gold occurs very coarse. The quartz carries a considerable amount of sulphurets. A good ten-stamp mill with four Frue concentrators belongs to the property. Three men are usually employed.

FESSLER MINE.

The vein courses 15° west of north, dips 70°, with porphyry and serpentine walls. It has been tapped by two tunnels about 250 feet long; these are not yet connected. About 100 feet of the vein has bee-

stoped. No mill is connected with the property, the owner working alone, crushing the quartz in a hand mortar. A pocket mine.

GRANT AND APPLE MINE.

This is situated across the ravine from the Fessler Mine, and the vein runs about parallel with it. Like the other it is a pocket mine, without a mill, employing three men.

THE BUCKEYE GRAVEL DRIFT CLAIM

Holds 80 acres of ground, worked by four partners. A tunnel is being driven through the slate bedrock to strike the Blue Lead bedrock tunnel. From 700 to 800 feet of the channel has been worked. This is an old mine being gleaned over.

RED STAR GRAVEL MINE

Has a frontage on the ridge of 600 feet, and extends back through the summit. It is opened by a tunnel 400 feet long. It is old ground, and three or four men are working out the front reserves. There is a capping of about 250 feet of lava and pipe clay, with from 4 to 5 feet of gravel. The gold, which is very fine, is all on the bedrock.

THE MAPLE GROVE GRAVEL MINE COMPANY,

About one half a mile from Alleghany, holds 140 acres of ground and a timber location. A bedrock tunnel, 100 feet long, cuts the channel, which is 250 feet wide, with 5 feet of cemented gravel. Two men are working on a contract to drive 400 feet of a new and deeper tunnel. The gravel pays about $6 per carload, equivalent to one ton. A water right of 7 to 8 inches under a 700-foot pressure belongs to this property.

BALD MOUNTAIN EXTENSION DRIFT MINE.

This property, located near Forest City, lies to the east of the old Bald Mountain, and is the most extensive drift mine in this section, comprising 1,600 acres. There are three channels in this neighborhood. The oldest and highest runs through the old Bald Mountain; this was cut through by a lava channel, 80 feet deeper than the bed of the upper one, and then there is a branch to the upper channel, on which the present Bald Mountain extension works are being prosecuted. No gold has been found in the lava channel, except at the point where it cut down through and below the main channel, and the gold from both sides of the cut washed into it. These gravel channels show white quartz gravel, with a little foreign matter. In the extension, 6 inches from the bedrock, an iron rust scale has formed over the gravel, which is quite hard, and below which the richest of the dirt is to be found; pieces weighing up to 11 ounces are occasionally met with.

The slate bedrock in the extension under the channel is perfectly white and very soft, making it easy to work through it. The present tunnel is from the opposite side of the ridge from which the former opening into the channel was made; it was run under the impression

that the gravel would be reached in a much shorter distance, and the hoisting up the old 30-foot slope would be got rid of. The altitude of the mouth of the new tunnel is 4,975 feet. The distance to gravel was found to be far greater than calculated on. The tunnel measures about 1¼ miles in length, and is about 15 feet below the bottom of the channel. It was continued 200 feet across the channel, but without reaching the opposite rim. The grade is 1 foot in 25. The channel courses northeast and southwest, with a capping of 1,000 feet of lava over 56 feet of gravel; it has been worked a distance of 125 feet. All the gravel in the channel contains some gold, but only 4 to 5 feet near the bedrock is sufficiently valuable to be mined. The channel drifts are carried 200 feet wide, and the gravel drifts 4 feet deep; one half of the gravel is cobbles and bowlders. Three upraises connect the channel with the tunnel. The mine is ventilated with a water blast. The tunnel dimensions are 7 by 8 feet. The tunnel is supplied with T rails. Twenty men on a shift, with two shifts in twenty-four hours, extract 100 carloads of gravel per shift, weighing a ton per car; a train of these cars, consisting of from ten to twelve, is run by mule power, consuming one hour to fill, run out, and return. To increase the output of the mine it will be necessary to employ some speedier method; perhaps electricity could be successfully introduced. In the old tunnel a specially constructed locomotive took the place of the mules. The different shifts are taken in and brought out by the mules. The gold from this channel is .962 fine. Spruce and pine timber is plentiful. Lumber costs $25 per thousand feet.

From Downieville, to the north and west, the trail passes over the serpentine belt toward Red Dog, flanking Mount Holly, likewise serpentine to Fir Cap, on the head of Goodyear Creek, over a belt of metamorphic rock and slate.

Altitude of Red Dog Mountain	4,250 feet.
Altitude of the Excelsior Mine on Fir Cap	3,750 feet.
Altitude of the divide between Excelsior and Monte Cristo	5,473 feet.
Fir Cap Mountain	5,200 feet.

The contact between the slate and serpentine passes north 22° west, close to the cabin of the Telegraph Mine. The serpentine belt is about 1,000 feet wide, and passes down Goodyear Creek and across the river near Goodyear Bar, where it is a mile wide. A branch of the serpentine connects near Monte Cristo and runs under the lava over to Excelsior Mine. This belt has been traced all the way to Spanish Ranch, in Plumas County. On the eastern contact of the slate the connection forms pretty much a straight boundary, while on the other side the serpentine sends out branches into the adjoining slate. It might be suitable to mention here, that under the writer's observations, through Plumas and Sierra, nearly all of the pocket ledges in these counties that are famous for producing coarse gold are in the proximity of the serpentine; whether there is any connection between these facts would be of interest to investigate.

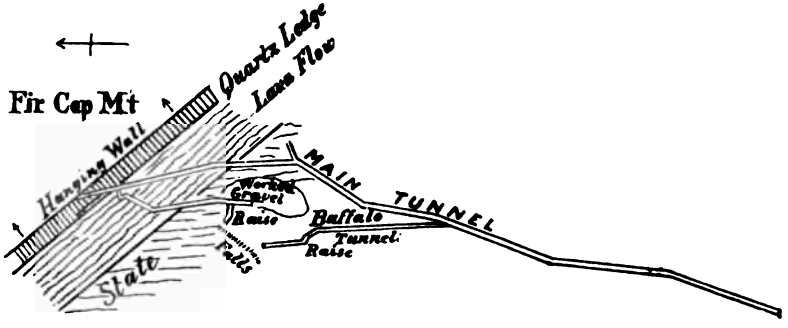
THE EXCELSIOR MINE

Lies 4 miles north of Downieville, and was first located in 1852. It includes the St. Lawrence, the Dead-broke, the Excelsior, and the Eagle claims, comprising 300 acres. It is an ancient channel, capped with 400 feet of lava; 26 feet of gravel in depth have been proved, how

much more is unknown. The top of the deposit is 5,850 feet above sea-level. The underlying bedrock has an altitude of 5,750 feet, and consists partly of quartzite, partly slate. A 300-foot bedrock tunnel has been run at a cost of $6 a foot. The course of the channel is northeast and southwest, containing free gravel. The channel drifts are carried 400 feet wide with 4 feet deep gravel drifts. The percentage of cobbles is one third. Twelve carloads a day are extracted by two men working day shifts; the cars weigh 800 pounds, and the yield is stated to be worth $2 per car; the gold sells for $18 an ounce. The water owned by the company can be delivered under a pressure of 170 feet. There are two channels in this ground; the front, or red channel, has never been worked to any considerable extent; the gravel is all white quartz; the gold is coarse.

THE TELEGRAPH MINE.

This mine comprises both a gravel drift mine and a quartz mine. It is situated 9 miles northwest of Downieville, on Fir Cap Mountain, at the headwaters of Goodyear Creek. It was located in 1889, and includes six claims. The channel courses northerly, is lava capped from 300 to 800 feet, and carries from 5 to 6 feet of gravel. The elevation of the lava cap is 6,200 feet, that of the underlying rock 5,200 feet; the bedrock is slate. In running the tunnel 2,600 feet, at a cost of $5 a foot, a quartz vein was cut 35 feet wide, having a northwest and southeast course, situated on the contact of the slate and serpentine; both walls are nearly perpendicular. Twenty feet of the ledge next the foot wall is rich in sulphurets, besides the free gold it contains; it is claimed that the sulphurets, which show galena, zinc, and iron pyrites, assay as high as $1,500 per ton. After drifting 100 feet on the vein, no deterioration in the quality of the quartz is perceptible. This vein does not show anywhere on the surface, being entirely lava capped. No stoping has been done.

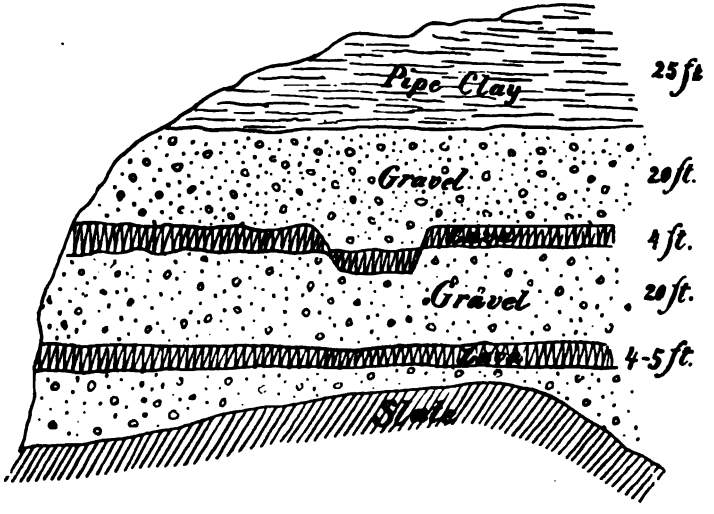


In the gravel channel the drifts are breasted 250 feet wide, and the gravel worked to a depth of 6 feet. One third of the gravel is cobbles and bowlders. No gravel is being worked at present; two men are drifting. The gold from this mine sells for $16 25 per ounce. The mine owns its own timber supply on the claim. The channel has been worked for 600 feet. At a distance of 1,200 feet from the mouth the channel is cut; the tunnel is being run ahead on the west side of the lava, to see if any gravel can be found above a high raise that is

encountered in the channel course. In some parts of the channel there is a layer of pipe clay between the gravel and the lava, but most of the lava lies directly on the gravel. The lava flow on the south side of the quartz ledge is about 200 feet in width. Between the main tunnel and the Buffalo tunnel the gravel has been excavated. It is proposed now to raise up from the Buffalo tunnel and work over the high bedrock, to find out if the gravel channel continues on the higher level.

Passing down the ridge from the Telegraph Mine, the road crosses the ridge and continues in a northwesterly direction to Cañon Creek, crossing first the little Cañon Creek to Craig's Flat, to Morristown, over auriferous gravel deposits. The divide between Slate and Cañon Creeks, on the road to Wahoo, has an altitude of 5,200 feet; farther south, at Scales Diggings, on the same divide, at the Cleveland Mine, the altitude on the slate bedrock between the town and the mine is 4,150 feet. This mine has been enjoined from working, notwithstanding they impound 80 per cent of the debris on their own ground. The gravel is cemented, and has to be broken by blasting previous to washing. The Cleveland Mine owners brought the first monitor into the county. On the same channel, situated on the opposite bank of Rock Creek, is the Union Hill Mine. Below, on the same creek, a company of twenty-two Chinese are working some ground they bought for $18,000.

Passing up the road from Scales Diggings through the Mount Pleasant ranch, with an altitude of 4,550 feet, the road continues north to Portwine and Grass Flat, on to Howland Flat, through an almost con-



tinuous series of small mining towns, the former seat of large hydraulic mines, but now nearly deserted. Near Poverty Hill the Portwine gravel channel is thought to unite with the Gibsonville channel, coming down on the east branch of Rabbit Creek, thence crossing Rabbit Creek and Slate Creek, in the neighborhood of Smith's Diggings. In the old works of Liberty Diggings, at Portwine, a very interesting section of the old gravel bank is to be seen, with recurring beds of gravel and lava. In the uppermost layer of the lava a section has slipped down its own thickness into the gravel immediately beneath without showing any

faulting of the gravel strata, either above or below. From the surface down the layers follow one another, 25 feet of pipe clay, 20 feet of gravel, 4 feet of lava, 20 feet of gravel, 4 to 5 feet of lava, 6 to 8 feet of gravel, on the slate bedrock.

EXCELSIOR DRIFT MINE,

In the Cedar Grove Mining District, was located in 1867. It contains 108 acres. Like the Lucky Hill Drift Mine, they are running for the Portwine channel; the latter mine has a tunnel 250 feet in length; they expect to have to run 1,500 feet beyond the present tunnel to strike the channel. It is contemplated to sink a series of shafts to define the course and limits of the channel.

PIONEER DRIFT MINE,

Situated in Grass Flat Mining District, was located in 1856. It lies 2½ miles northeast of Portwine and contains 300 acres. The course of the channel is southwest. It has a lava capping of 50 feet, and over 50 feet of gravel; the bedrock is diabase. The works include a tunnel and two shafts, the latter supplying the ventilation for the former. The cost of running the tunnels amounted to $14 per foot; that of the shafts $15 per foot. The work was performed with machine drills (Burleigh) and a Parke & Lacy compressor. Six feet of gravel next the bedrock is drifted out; part of it is cemented, and only a small proportion is bowlders, not more than 10 per cent. With a crew of three or four men working one shift per day, three to four carloads of gravel is extracted, valued at $1 75 per carload of 1 ton. The gold is worth $18 50 per ounce. About 50 inches of water is used. The mine is supplied with its own fir and spruce; the lumber has to be hauled 10 miles, and costs $30 per thousand feet. The source of the water supply is Slate Creek; 2 miles of ditch conveys the water to the mine, where it is delivered under a 100-foot head. One thousand feet of the channel has been worked.

THE MIDAS GOLD MINE,

One quarter of a mile from Howland Flat, owns 110 acres. The channel, which is lava capped, courses southwest. The capping is in places 200 feet, and runs down from that to a feather edge; the gravel is from 40 to 60 feet in depth, lying on a slate bedrock. The top of the deposit has an elevation of 5,600 feet; the underlying bedrock 4,253 feet. The mine is worked through a tunnel which cost $21 a foot to drive; the gravel is free. The gravel drifts are from 6 to 9 feet in depth; half of the gravel consists of bowlders. About fifteen men are employed about the mine, working in two shifts; they average from five to six carloads of ton weight per shift. The gold is .945 fine. The water supply is obtained from Slate Creek, and brought to the mine through 5 miles of ditch and delivered under 80 feet of head. The water costs 25 cents for ten hours, using 100 inches.

SOME ADDITIONAL SIERRA COUNTY MINES.

By E. A. Wiltsee, E.M., Assistant in the Field.

THE BIGELOW MINE.

The Bigelow Mine is situated one quarter of a mile northwest of Sierra City, at an altitude of 4,400 feet. This mine is an extension of the Sierra Buttes Mine, adjoining it on the northeast. The dimensions of the property are 1,800 by 600 feet. The mine is 52 miles from Truckee, and freight from San Francisco can be delivered at a cost of from $23 to $25 per ton. The course of the vein is northwest and southeast, dipping northeast at an angle of 40°. The average width of the vein is from 6 to 8 feet, having a width of 30 feet in places. There are three veins in the property, corresponding to three of the veins in the adjacent Sierra Buttes Mine. Operations are at present confined to the foot wall vein. The mine is opened by two tunnels. The upper, or No. 1 tunnel, is 80 feet on the vein, and gives about 40 feet of backs. The ore shoot in this tunnel is 70 feet in length as far as driven in. The vein exposed is a large one, and all the ore of good grade, some portions of it being very rich. The No. 2 tunnel is farther to the southeast; it is crosscut for 125 feet, when the vein is intersected. The tunnel is then driven 120 feet on the vein, this tunnel being advanced to bring it under the ore shoot exposed in the No. 1 tunnel. Tunnel No. 2 is a little less than 50 feet vertically lower than No. 1, but will give in the neighborhood of from 70 to 80 feet of backs. The vein in this lower tunnel is very large, having a width of 30 feet at places. The property has only very recently been opened, and developments are as yet necessarily limited. A raise through from No. 2 to No. 1 tunnel gives ventilation.

The cost of mining is low, and will not exceed $2 per ton. The ore is hauled to the Sierra Buttes mill, ten stamps being run upon this ore; the hauling costs 40 cents per ton. The ore is a free-milling quartz, containing some little mineral at times, and showing coarse gold.

This property has been in operation but a very short time. The last month's run was very satisfactory, the ore averaging in the neighborhood of $15 per ton, exclusive of concentrates. Eight men are employed in the mine and three in the mill; miner's wages are $3 per day.

MERCER AND SALINAS MINE.

The Mercer and Salinas Mine is situated 7½ miles southwest of Sierra City, at an altitude of 5,700 feet. The entire property contains three separate veins, the claims upon the various veins having dimensions of 3,000 by 600 feet, 1,500 by 600 feet, and 1,500 by 1,600 feet, respectively. The present operations are being conducted on the easterly, or Mercer and Salinas vein, this location having dimensions of 3,000 by 600 feet. The mine is distant from the nearest railroad point, Nevada City, almost 60 miles. Freight delivered at the mine costs $20 per ton from this point.

The average width of the vein is 4 feet. The mine is opened by two tunnels. The upper, or No. 1, is 560 feet in length, attaining a vertical depth of 104 feet from the surface. Tunnel No. 2 has a length of 900 feet, and is situated under No. 1 a vertical distance of 112 feet. The

ore shoot is intersected in the No. 1 tunnel at a point 100 feet from the mouth, and is 90 feet in length. In the No. 2 tunnel the shoot is met 500 feet from the mouth, and has a length of 160 feet. The ore shoot has a decided trend to the west. In the No. 2 tunnel, at a point 700 feet from the mouth, a shaft is sunk to a depth of 50 feet. The cost of driving the tunnels is $3 75 per foot, including the cost of timbering. A second shoot of ore outcrops on the surface 600 feet from the first shoot. The No. 1 tunnel is being extended to intersect this shoot. Ventilation is afforded by a system of raises, or air shafts, to the surface. There are two raises from tunnel No. 1, the first at a point 250 feet from the mouth, and the second 345 feet in. The raises from tunnel No. 2 are also two in number. The first is at a point 300 feet from the mouth, and the second 610 feet, being vertically under and connecting with the second raise in the No. 1 tunnel. Timber is abundant and is cut upon the property of the company. Lumber comes from either Sierra City, costing $35 per thousand feet, or from Cole & King's mill, at a cost of $40 per thousand feet, delivered.

The company has built 3½ miles of road. Water power for the mill is obtained from Nigger Cañon, 25 inches being available at the driest season of the year; this water is brought in by a ditch 2 miles in length. The ore is transported to the mill by a tramway 1,200 feet in length, around the face of the hill; at the extremity it is lowered down a gravity tramway, 330 feet in length, to the mill. The cost of transporting the ore to the mill is 12 cents per ton. On account of its exposed position the transportation is prevented by deep snow. The ore is a banded, ribboned quartz, containing free gold and a small percentage of sulphurets, less than one half of 1 per cent. The total cost of mining and milling is $2 26 per ton; the average grade of the ore is from $4 50 to $5 per ton free gold. The ore is reduced in a ten-stamp mill; the stamps weigh 850 pounds, drop 6 inches eighty times per minute, and crush a total of 18 tons of ore per day through No. 8 slot-punched screens. The height of discharge is 6 inches. Cast-iron shoes and dies are used, costing 6 cents per pound, delivered. The wear of shoes and dies per ton crushed is small and averages one third of a pound per ton. The dimensions of screens inside frames are 52 by 6 inches; the screens are inclined. Front and back inside battery plates are used, the front plate having a width of 6 inches and the back plate about the same width, situated so as to receive the upper portion of the wash and protected by a hood from abrasion by means of the ore charged. As a result, the percentage of amalgam received in the battery is very high, averaging 90 per cent. The apron is 5 feet wide and 4 feet long; the sluice run 18 inches wide and 16 feet long. All plates are silvered, and 10 per cent of the amalgam is saved on this outside run. Two concentrators are used to receive the sulphurets; the batteries are fed by hand. Three men are employed in the mill, three on outside work, and six in the mine. Wages paid are $50 per month and board. Power water is delivered at the mill with a head of 100 feet, a Pelton wheel being used.

CLEVELAND MINE.

The Cleveland Mine is situated 5 miles southwest of Sierra City, at an altitude of 4,450 feet. The mine was located in 1886, the property comprising three full-length claims on the vein, the dimensions of the

property being 4,500 feet in length by 600 in width. The course of the vein is northwest and southeast, dipping to the northeast at an angle of 80°. The average width of the vein is 1 foot.

The mine is opened by a series of three tunnels. The upper, or No. 1, tunnel is 700 feet in length, and attained a vertical depth on the ore shoot of 100 feet. The ore shoot was 200 feet in length in this tunnel, and has been stoped out to the surface. Tunnel No. 2 is under No. 1 a vertical distance of 100 feet, and is a little over 700 feet in length. The ore shoot in this tunnel was 250 feet in length, and has been stoped out. An upraise was made to tunnel No. 1, 250 feet from the mouth. Tunnel No. 3 is 1,500 feet in length, the ore shoot being intersected at a point 730 feet from its mouth. The ore shoot in this tunnel is 300 feet in length. This tunnel is 280 feet vertically lower than No. 2. It is connected with No. 2 by an upraise at a point 950 feet from its mouth. The formation is a slate in both walls. The tunnels have cost on an average $3 per foot, including the cost of timbering. Timbers used are pine and fir poles, costing 2½ cents per running foot. A shaft is sunk on the ore shoot below the No. 3 tunnel to a depth of 112 feet. Stoping is carried on at present from the level at the bottom of the shaft. Hardly any water is encountered. Hercules No. 2 powder is the explosive used, a little over 2 pounds per ton of ore extracted being used. The cost of mining averages $4 per ton. Timber delivered costs $22 50 per M.

One and one half miles of road has been constructed, at a cost of $4,000. The ore is a ribboned quartz, containing a very considerable percentage of pyrite, in the neighborhood of 5 per cent, and having a value of $80 per ton. The ore is transported from the mine to the mill by a gravity tramway 175 feet in length; the transportation costs 6 cents per ton. The ore is crushed in a twelve-stamp mill, four stamps to the battery, with a capacity of 1½ tons per stamp. The weight of the stamps is 750 pounds, dropping 6 inches eighty times per minute. The height of discharge is 6 inches. Chilled iron shoes and dies are used, crushing through No. 8 slot-punched screens. The apron plates are 5 feet by 4 feet in size, and the sluice run 13 inches wide by 15 feet long. The mill is fed by hand; 75 per cent of the amalgam being recovered in the battery, and 25 per cent from the plates. There are no concentrators in the mill. Ten men are employed in the mine and four in the mill. Wages paid, $3 per day to miners. The mill is run by a 3-foot Pelton wheel, the power water being delivered under a head of 300 feet.

WILLIAM TELL MINE.

The William Tell Mine is situated 1½ miles southeast of Sierra City, with an altitude, at its upper tunnel, of 5,500 feet. The property consists of five full-length claims. The course of the vein is east and west, dipping north at an angle of 75°. The average width of the vein is 8 feet. The formation in the hanging wall is a slate; the foot wall is porphyry. The mine is opened by three tunnels. Tunnel No. 1 is run on the vein, and is 90 feet in extent. The ore shoot worked was 70 feet in length, being entirely stoped out above this level; the vein averaged 3 feet in width. This tunnel is on a different vein from that encountered in the No. 2 tunnel. Tunnel No. 2 is crosscut for 250 feet, when the vein is intersected and driven on for 170 feet. This tunnel is vertically lower by 175 feet than No. 1. The ore shoot is 120 feet long, and

averages 8 feet in width. There is a raise through to No. 1, insuring perfect ventilation; stoping is now being carried on above this tunnel. Tunnel No. 3 is at present being driven to intersect the vein. It is crosscut and is in 490 feet; it is expected to intersect the vein in a little over 100 feet. This tunnel is costing $8 per foot, and is under tunnel No. 2 a vertical distance of 500 feet. Whatever timber is needed is cut from the property. The ore is a free-milling quartz, some of it showing gold very freely. The company has a prospect mill situated at tunnel No. 2. There are six stamps in this small mill, weighing about 150 pounds each. The stamps drop 6 inches eighty times per minute. The mill has a capacity of 2½ tons per day. The ore from tunnel No. 1 was conveyed to the mill by a wire-rope tramway. This mill has been run on selected ore, that crushed averaging from $20 to $25 per ton. It is stated that all the expense of development has been paid from the ore crushed in this small mill; the average of the whole vein is stated at $7 per ton. At present eight men are employed, seven miners and one mill man. The mill is run by water power, secured from a stream farther up the cañon.

BUTTES SADDLE MINE.

This mine is situated under the crest of the Sierra Buttes, at an elevation of nearly 7,000 feet. The dimensions of the claim are 3,000 by 600 feet. The mine is about 1 mile north of town, but about 3 miles by the wagon road. The course of the vein is east and west, dipping north at an angle of 60°; the average width of the vein is 3 feet. The mine is opened by two tunnels. Tunnel No. 1 is 80 feet in length, attaining a depth from surface of 80 feet at its extremity; the average width of the vein in this tunnel is 3 feet. Tunnel No. 2 is in 1,200 feet; it is under No. 1 a vertical distance of 250 feet. The ore shoot is encountered 400 feet from the mouth. Two shoots have been cut in this tunnel; the first is 80 feet in length. Five hundred feet of barren ground is passed through, when the second shoot is met. This shoot is 120 feet in length, as far as developed, with ledge still in the breast of the tunnel. The average width of the first ore shoot is 3 feet, and that of the second 5 feet. A winze sunk on the first ore shoot in the lower tunnel to a depth of 33 feet shows a 7-foot vein in the bottom. The cost of the lower tunnel is $3 per foot, including cost of timbering. The property is being developed, no facilities for crushing having yet been arranged. The ore exposed shows gold freely, and is undoubtedly of pay grade.

INDEPENDENCE MINE.

The Independence Mine, a portion of the Sierra Buttes property, is being worked at present under lease. The mine is worked through a new tunnel, driven west on the vein from the outcrop in the Independence ground. The course of the vein is northwest and southeast, dipping northeast at an angle of 50°. The tunnel is in, at present, 300 feet, running through the old workings of the mine. Pillars that were left as too low grade to pay in former years are being taken out. The width of the vein is 15 feet, of which 4 feet is stoped on the foot wall, containing the most pay. The cost of mining is about $2 per ton. From 50 to 100 feet farther will carry the operators into new ground, where, in all probability, ore of good grade will be encountered. The ore tracted is hauled to the Sierra Buttes lower mill, ten stamps of which

are kept running upon this ore. The cost of hauling is $1 per ton. Six miners are employed in the mine. The tunnel driven is about on the same level as the No. 3 tunnel of the Sierra Buttes Mine.

GOLDEN KING MINE.

The Golden King Mine is located on the east bank of the South Fork of Kanaka Creek, at an altitude of 3,950 feet. The dimensions of the property are 1,500 by 600 feet; the location was made in May, 1890. The nearest town, Alleghany, is distant 1½ miles to the east. The nearest railroad station, Nevada City, is distant 39½ miles; freight at the top of the hill above the mine costs $20 from this point. The course of the vein is north and south, dipping west at an angle of 85°; the average width of the vein 2½ feet. The vein is inclosed in black slate in both walls. Mariposite occurs frequently in the fissure.

The mine is opened by a tunnel on the vein 118 feet in length at date of visit. This was being steadily advanced on eight-hour shifts. The cost of driving the tunnel is $5 per foot, including the cost of timbering. A vertical depth of 110 feet is attained in the breast of the tunnel, owing to the rapid rise of the hill. The vein in this first ore shoot is of good grade and regular in size the entire distance. The vein in the breast has a size of 18 inches, the tunnel being advanced to intersect a second shoot of ore disclosed in the No. 1 tunnel above. The No. 1 tunnel is 93 feet vertically over tunnel No. 2, and is 112 feet in length. The vein in this second shoot has an average width of 18 inches and is similar in character to the ore in the first shoot. The breast of tunnel No. 2 is vertically under the mouth of No. 1 tunnel, and the ore shoot will be intercepted in a few feet. A winze sunk under from No. 2 tunnel at a point 100 feet from the mouth, to a depth of 54 feet, shows a high-grade vein of ore 2½ feet in width in the bottom, the ore being very heavily mineralized. Timbers and some lagging are cut and made on the claim, which is heavily timbered with first-growth spruce and pine.

The mine owns a valuable water right in Kanaka Creek. The fall is rapid, and there is over 100 inches of water at the driest season of the year. Safety Nitro No. 2 is the explosive used. Lumber is obtained in the vicinity of the Mountain House, and costs $30 per thousand feet, delivered.

The ore is a heavily mineralized, easily crushed quartz, containing an average of 10 to 12 per cent of very high-grade arsenical pyrites, in addition to free gold. Crystals of telluride are seen dotted through the pyrite. It is stated on good authority that the ore will return $40 per ton, of which amount probably the greater portion is contained in the pyrite, or rebellious constituent. No stoping has as yet been done under the present ownership; ore worked in an arrasta produced good returns in free gold, no sulphurets being saved. It is the intention of the company to erect a crushing and chlorination plant. Over half of the value is doubtless contained in the sulphurets, which are certainly of very high grade. Assays on this product show a value of several hundred dollars to the ton.

The development of the mine is being rapidly proceeded with. Ten men are employed, all on dead work, and two men on outside work. Wages paid, $3 to miners; $2 50 on outside work. The entire development has been made since the last report.

RISING SUN MINE.

The Rising Sun Mine is situated at an elevation of 4,430 feet, on the high ridge above the South Fork of Kanaka Creek, 1½ miles east of the town of Alleghany. The location is an old one, made in 1864. Nevada City, the nearest railroad point, is distant 39½ miles. The course of the vein is northeast and southwest, dipping northwest at an angle of 70°; the average width of the vein is 4 feet.

The mine is being opened by a shaft on the vein, and a tunnel driven crosscut through the foot to cut the vein at a depth of 200 feet. The tunnel is in at present a distance of 200 feet. The shaft is down 70 feet, and is being carried in the foot wall under the vein, which is of large size, averaging 4 feet, and of good appearance. The length of the ore shoot is as yet unknown; the vein crops out strongly for several hundred feet on the surface. The mine is in the development stage, the opening up being actively prosecuted. Twelve men are employed: eight miners, two windlassmen, one blacksmith, and one man on outside work.

EAGLE MINE.

This mine is located in the Chipp's Flat District, at an altitude of 4,400 feet. The course of the vein is north and south, dipping to the east, with an average width of 3 feet; the ore carries between 2 and 3 per cent of sulphurets. The dimensions of the mine are 1,500 feet in length by 600 feet in width. The hanging wall is a syenite, with a serpentine foot.

The mine is opened by a tunnel 400 feet in length, and attaining a depth of 150 feet from the surface. Water power can be obtained by driving a tunnel in from the creek, which would give nearly 500 feet of reserves.

GIBSONVILLE MINING DISTRICT.

North of the town of Downieville lies the well-known Gibsonville and Howland Flat Gravel District. Profitable operations have been carried on in this neighborhood for many years, and the bullion output has been a very large one. In this north country, as it is locally termed, there are three extension ridges, in each of which is a well-defined gravel channel. The Gibsonville Ridge lies the farthest to the west, between the South Fork of Feather River and Slate Creek. The general direction of the Gibsonville Ridge is southwest and northeast; the length of the gravel channel, as far as developed, is 12 miles. The bedrock is slate, the width of the channel worked varying from 200 to 400 feet. Some slightly cemented gravel is found in the Gibsonville channel. The ridge is high, the elevation varying from 5,000 to 6,000 feet, the channel being covered with several hundred feet of volcanic capping. On the Gibsonville Ridge are the mining towns of Gibsonville, Hepsidam, and La Porte.

The Howland Flat Ridge lies east of the Gibsonville Ridge, between Slate Creek and Cañon Creek. The course of this ridge is more nearly north and south, and the extent of the channel nearly 18 miles. The channel is wide and strong; the width of the gravel worked varying from 1,000 feet, in the Union claims, down to 400 feet; the average width is about 600 feet. The width between the rims is about one half mile. The total depth of the gravel deposit is from 100 to 200 feet, the

volcanic capping attaining a depth of 800 feet. The gravel from this channel is all free and readily worked. The mining towns of Howland Flat, St. Louis, Portwine, Grass Flat, and Scales Diggings are on this ridge. This ridge has been extensively mined for many years, by far the greater part of the channel being now worked out. The gravel from both these channels is of good grade, yielding from $2 to $2 50 and $3 per ton. As the gravel is free and the contents easily recovered, and the pay breasted to a depth of 4 feet at least, it will be seen that operations have been very productive and profitable. Wherever the main channel has been entered in these two ridges, pay gravel has been secured. The Gibsonville channel has not been worked as exclusively as the Howland Flat, and about 5 miles of unworked ground is now in the possession of one company.

East of the Howland Flat Ridge, between Cañon Creek and the North Fork of Yuba River, is the Grizzly Ridge; this ridge also contains a gravel channel. The gravel is, however, more spotted, and pay gravel is not always found when the main channel is opened. This gravel belt, containing the three mentioned ridges, has a maximum length of 18 miles and a width of 12 to 14 miles. The most prominent mine at present working is the Thistle Mine.

THISTLE DRIFT GRAVEL MINE.

The Thistle Mine is situated 3 miles south of the town of Gibsonville, on the Gibsonville Ridge. The nearest available railroad point is Oroville, distant nearly 50 miles by road; communication with Downieville is open by trail only. The property of the company is a very extensive one, extending about 5 miles on the channel. The deposit is an ancient river channel, covered with several hundred feet of volcanic capping. The depth of the gravel deposit is varied; in places, including pipe clays, sand strata, etc., it attains a depth of over 100 feet. The depth of the stratum of pay gravel breasted is about 4 feet. The width of the channel is not yet determined by the openings made, but is proved to be extensive. The bedrock is slate.

The mine is opened at present by a shaft 535 feet in depth. There are two hoisting compartments, containing two cages, upon which the ore cars are hoisted; the empty cage goes down as the loaded cage comes up. The water is lifted by a steam pump, about 8 miner's inches being hoisted at present. The company is running up the channel from the shaft, and has connected with an old shaft 600 feet farther up the channel, and which never quite reached the bedrock. The mine is ventilated by a blower, the connection with the old shaft materially aiding. The gravel is a free gravel, the gold being recovered by washing through sluices with a monitor, in the usual fashion. The percentage of cobbles and bowlders is large, and will reach nearly one half. Two shifts are worked per day, a total of seventy-five men being employed. The gravel is run out to the washing dump and washed by monitor under pressure. The sluice is a long one, and made in the ordinary manner. It is the intention of the company to bring in a lower tunnel over 2,000 feet farther down, to bottom the channel. In this manner the numerous disadvantages under which the mine is at present working will be obviated, and expense for hoisting and pumping, necessarily heavy, will be stopped. The grade of the gravel is good, running from $2 to $3 per ton.

SISKIYOU COUNTY.

By R. L. DUNN, E.M., Assistant in the Field.

Siskiyou County is situated in the extreme northern end of the State. Del Norte and Humboldt Counties separate it on the west from the Pacific Ocean, and Modoc County comes between it and the State of Nevada on the east. Its southern boundary is on the counties of Trinity and Shasta, and the northern the State of Oregon.

Approximating in shape a rectangle, its greatest dimension extends east and west 116 miles, and its lesser 56 miles north and south. Topographically, the eastern two thirds is a plateau from 2,500 to 3,500 feet in elevation, from which a number of isolated peaks and several mountain ranges rise from 2,000 to 5,000 feet higher.

The culminating point and the striking figure of the Siskiyou landscape is Mount Shasta, a dead volcanic cone 14,511 feet high. The western third is rugged and mountainous, a tangle of precipitous cañons and sharp mountain ridges and peaks.

The drainage system of the county is almost exclusively that of the Klamath River and its tributaries, Salmon, Scott, and Shasta Rivers, and numerous smaller creeks and cañons. The headwaters of the Sacramento and McCloud Rivers find their sources in the east and south slopes of Mount Shasta, and drain a small portion of the county.

The bulk of the agriculturally desirable land is found in Scott and Shasta Valleys. There are other scattered tracts of a few acres along the Klamath River, and a more desirable area around Cottonwood Creek, but aside from the latter they are of value only to the more important mining industry. Timber is abundant, covering the mountain ranges in the north, west, and south.

The mountain system belongs to the Coast Range, the Sierra Nevada system disappearing before Shasta is reached, unless, indeed, that be considered the northern end of the Sierra system. These mountain ranges lie, for the most part, in the western half of the county, the eastern mountains being the volcanic cones to which reference has been made. The entire northeastern part of the county—thirty-four townships—is covered with lava and has no value whatever. Though the mountains of the western half belong to the Coast Range system, their general geological character is that of the Sierras rather than that of the more southern Coast Range. Granites, diorites, and metamorphic slates and limestones similar to those of the Sierra make up their mass. Between these western mountain systems and the lava beds, covering a large but undetermined area of the northern central portion of the county, including certainly much of the drainage area of the Shasta and Little Shasta Rivers and Cottonwood Creek, is a section the characteristic rock of which is a fossiliferous sandstone. Near Yreka, and generally along its western edge, it becomes a conglomerate of quartz and other pebbles. Stratified with it in the Shasta and Willow Creek

Valleys, coal seams are found. Also on its western rim it is found to cap a buried river channel of considerable size filled with auriferous cemented gravels.

My examination of it was so limited that it is almost impossible to make definite statements concerning the geological phenomena it presents; the evidence of the buried river with its auriferous gravels and the coal seams indicate its formation in a lake area rather than ocean. Also, that it is subsequent in point of time to the elevation of the mountain masses west of it, and prior to the erosion of the Klamath drainage system. It seems reasonable to me that the buried river is an ancient channel of the Sacramento, eroded prior to the volcanic activity that built up Shasta, and covered 150,000 square miles of Oregon, California, and Nevada with lava flows. Indeed, it is probable that it was the elevation of Shasta that cut off the channel and converted its drainage basin into a great inland lake, in which the sandstones and coal strata were formed.

The sandstones, blue gravel channel, and coal strata are all tilted, dipping from 10° to 15° to the east, and broken by faults far more than is observable in the blue lead channels of the Sierra. The sandstones contain numerous shell and other fossils, a determination of which will undoubtedly throw considerable light on the phenomena connected with the formation of the ancient river system of the State. The auriferous rock belts of Siskiyou, Trinity, and Shasta Counties constitute a system distinct from the Sierra systems, and in a general way can be considered together. The system consists of four belts, having a rough approximation to parallelism in strike to the northeast and southwest, the Sierra systems generally striking to the northwest and southeast. The most northerly and westerly of these four belts lies, for the most part, in Oregon. The southern end is in northeastern Del Norte County and in northwestern Siskiyou. The placers of Indian Creek, in the latter county, and Smith River, in the former, are formed from its erosion. Otherwise very little is known of it.

Southeasterly from it and distant about 20 miles is the second belt. The southern end of it is the New River Mining District of northwestern Trinity County. Thence, on a course approximately 20° east of north, it crosses Siskiyou County and constitutes its main mineral belt, the source of practically all of its gold. On its course are the rich ledges of Knownothing Creek, Black Bear, and Eddy's Gulch, in Salmon River District; those of Quartz Valley, Deadwood, and Humbug Cañon Districts, and the newly discovered ledges on Hungry and Cottonwood Creeks close to the State line. From its erosion have been formed most of the placers of the county; all, indeed, except those of Indian Creek, already noted, and the South Forks of the Salmon and Scott Rivers. The blue lead ancient river channel already noted in all probability derived its gold from this same belt.

Ten miles southeast of this belt is the third. Its southern end is in Trinity County, forming East Fork and Cañon Creek Mining Districts. Thence, its course is approximately north 20° east, marked by many ledges in the mountains about the headwaters of the west side tributaries of Trinity River to its final disappearance about the headwaters of the South Forks of the Salmon and Scott Rivers in southern Siskiyou. Though there have been no notable developments in quartz mines, the placers, resulting from its erosion, are very extensive and

rich in Trinity County. Also, the South Forks of the Salmon and Scott Rivers have obtained their gold from this source.

The fourth of the belts is 15 miles distant southeast. Its southern end is Bully Choop District, on the line between Trinity and Shasta Counties, and on its northward course it includes the rich ledges of Deadwood District, in Trinity County, and French Gulch, in Shasta County.

Of the four, the second is the best defined and most persistent. Its length is 75 miles, and its width varies from 5 to 10 miles. Its characteristic rocks are metamorphic slates and limestones, serpentines, and intrusive dikes of trap and porphyry. The belt is interrupted and broken at several points, and is by no means prolific in auriferous quartz veins throughout its entire extent. Neither are the prevailing rocks the same in all the quartz districts.

A noticeable feature of the occurrence of the auriferous veins is their relation to the culminating peaks of the mountain systems crossed by the belt. The ledges of the New River and Knownothing Creek lie on opposite sides, but well up toward the summit of one of the highest peaks of the range of mountains between the watersheds of the Salmon and Trinity Rivers. The Black Bear and Eddy's Gulch ledges strike into Ball Mountain, a prominent peak of the mountain mass lying between the North and South Forks of the Salmon. Tanner's Peak, north of Sawyer's Bar, has a cluster of ledges, though none are being mined at the present time. Deadwood and Humbug Districts are on the slopes of Old Baldy Mountain, the culminating peak of the Yreka range, and the ledges extend almost to its summit. North of the Klamath, the Hungry Creek ledges are close on to Mount Sterling. Oro Fino and Quartz Valley are on opposite sides of a minor isolated mountain, the only exception to the rule indicated.

The actual auriferous area of Siskiyou County is small; practically it is scattered over the western three fifths of the county. There are only six quartz mining districts, three of which are generally termed the Salmon River District, but placers are widely scattered and cannot be so closely grouped. For convenience, however, the mining districts of the county may be named as follows: Salmon River District, including the quartz and placers of the entire Salmon River drainage system; Callahan's Ranch, being the placers of the South Fork of Scott River; Quartz Valley, the quartz and placers of the valley of that name in the northwestern corner of Scott Valley; Scott Bar, placers and quartz of the Scott River from where Mill Creek joins it to its junction with the Klamath River; Klamath River, being the placers in the cañon of the river from Cottonwood Creek to where the Salmon River comes in, including many old districts, unimportant now; Humbug Creek, the quartz mines on the several branches of Humbug Creek east of Old Baldy summit; Deadwood, the quartz mines on the opposite slope of Old Baldy, and the placers of Indian and McAdams Creeks, tributaries of Scott River heading in Old Baldy; Hungry Creek, quartz mines in that stream and on the headwaters of Cottonwood Creek; Yreka, the quartz mines and placers near the city and Hawkinsville; and Henley, which might more properly be termed Blue Gravel.

The general conditions under which mining is followed in Siskiyou County are fairly favorable. All the districts except Salmon River are accessible by wagon road, and to that a wagon road is under construc-

tion from Etna. The cost of machinery, powder, and iron has always been high by reason of high transportation charges. On the other hand, wages of miners are not high, the cost of living being cheap. Scott Valley, in the heart of the mining districts, is a rich agricultural region practically supported by mining. The cost of packing into Salmon River District is not excessive, and is less than to many localities in the mining counties having road communication. Most of the quartz plants are old and light. I found only two five-stamp batteries in the county. The weight of stamps is, as a rule, not over 750 pounds, most of them only 650 pounds. Water power is quite generally used, but with large diameter hurdy wheels. Only one Pelton wheel is used on a milling plant. There are none of the improved concentrators of sulphurets used, though their employment seems desirable. At one mill, the McArthur-Forrest cyanide process is being introduced.

As a productive industry, mining is profitably followed in Siskiyou County. The annual gold product is increasing, though some of the placer districts are becoming worked out. Very few of the mines are owned outside of the county, so the profits remain with the miners. Most of the mines are so managed that they have paid for their own development. In the aggregate about one thousand men find direct employment in mining, four hundred of them being Chinese.

The conditions for the permanence of the industry seem favorable. The quartz veins are no longer abandoned at the water level on the supposition that the pay does not go down. When gone down on they are found to still have gold that can be profitably extracted. The placers of Quartz Valley and Salmon River will likely increase their gold yield as the result of mining operations on a larger scale. The blue lead channel is undoubtedly rich in gold for miles of its course. Untouched as yet, it will ultimately be profitably mined for many years.

Electrical transmission of power from the large flow and considerable fall of the rivers will cheapen milling and enable it to be carried on continuously where only a few months' operation is possible now.

SALMON RIVER DISTRICT.

This district is the largest in Siskiyou County, and comprises its entire southwestern corner. It is the drainage area of the Salmon River and its tributaries. Topographically it is a tangle of mountain ridges separated by precipitous cañons and river gorges. There are no mountain plateaus or alluvial valleys. All the fairly level land in the district consists of a few bars on the Salmon River and its branches. The agricultural land is so limited in extent and widely scattered that the district is practically entirely dependent on supplies from the outside. It is, without exception, the most inaccessible mining district in the State, all its means of inlet and intercommunication being by trails until the last few months, which have witnessed the construction of a wagon road from Etna, in Scott Valley, to Sawyer's Bar, the principal town in the district. It has been a district so isolated that many children have grown up in it to manhood who have never seen a wagon or carriage.

Its mining industry is diversified among the several branches of placer and quartz mining and very much scattered. The mines are, however, pretty generally profitable, aggregate a large annual produc-

tion, and maintain a considerable population. Placer mining is followed along the beds and bars of Salmon River and its two principal forks; also, to a less extent, in some of the smaller side cañons making up into the gold-bearing quartz belts. As a general proposition the river-bed claims are pretty generally worked out. This kind of mining is now limited to a half dozen claims on the North Fork of Salmon River and on Eddy's Gulch, which empties into it at Sawyer's Bar. The low bar claims, where rich enough to be worked by derricks, as has been generally the case on the North Fork, are also worked out, with exceptions that still maintain a few individual miners. On the main river and on the South Fork, however, large areas of these bars are still untouched. On these streams the placer mining industry seems to be on the up grade instead of the reverse, as is the case in other California placer districts. New ditches are being constructed and the capacity of old ones being increased to hydraulic the low bars and to work a number of high bars and benches of these same rivers. Most of the latter have remained unworked up to the present time. The early miners, after working out the river beds and ravines, left for other gold fields without making any attempt to mine the higher deposits, which required a water supply brought in ditches, frequently from distant sources, and the investment of capital in other plant and dead work of opening. It is in quartz mining, however, that the permanent value of the district is to be realized. The main gold-bearing rock belt of the county crosses through the middle of this district. At its southern end, on the borders of Trinity County, just over the divide from New River, are quartz mines on Knownothing and Methodist Creeks.

Northerly, or rather northeasterly, and in almost the geological center of the district, is an extensive group of mines noted as gold producers. They lie at the heads of Black Bear, Eddy's, and White's Gulches, distant from 4 to 10 miles from Sawyer's Bar. Still farther northeasterly are quartz ledges on what is called Jackass Gulch, on the north side of the North Fork. The most noted mine is the Black Bear, which has been one of the great producers of the State. Others are the Klamath, Gold Ball, Fagundes, Uncle Sam, and Gold Run. In addition to these producing mines, there are a number of properties more or less prospected, and giving indications of developing into large gold producers.

As a general conclusion, it may be safely asserted that the district is not prospected for gold-bearing quartz as yet. The country is heavily timbered and brushy, precipitous, and the surface broken so that the quartz veins rarely show in place at the surface. Trails being the only line of communication, the expense of getting a plant in place is very considerable. If the prospect is a failure the plant almost invariably becomes a dead loss. To miners whose only capital is their manual labor and its immediate returns, the development of any prospects, except such as have high-grade and specimen ore close to the surface, is impracticable. Also, they have received very little assistance from outside capital. The construction of the Etna and Sawyer's Bar wagon road has, however, removed many of these restrictions on development, so that the discovery and opening of new quartz mines may be reasonably anticipated.

On the North Fork of the Salmon, just above the town of Sawyer's Bar, and on the south side of the river, are two high bench placers that

are being worked by drifting. The pay gravel is wheeled out of the drifts and dumped into a box chute set on the slope of the mountain, discharging into a sluice on the bank of the river. It is claimed by the owners that working in this primitive way they realize from $3 to $10 a day to the hand. For the purpose of furnishing water to hydraulic these claims and other high ground, now unavailable by reason of having no water supply, a ditch has been projected to divert the water of Russian Creek, a tributary of the North Fork. In addition to its direct utility for placer mining, it will furnish power, utilizable by electrical transmission, for the running of the quartz mills at the head of Eddy's Gulch. The surveyed length of the ditch is 15 miles and its estimated cost $25,000.

Between Sawyer's Bar and Forks of Salmon, a distance of 18 miles, there are eleven placer claims. Of these, seven are small river and bar claims, worked by ground sluicing or derricks in a primitive, small way. They are insignificant in extent and annual yield. Two men on the average find work for a few months every year in these claims. The other four are hydraulic claims on high benches and bars.

The Ahlgren, or Russian Hydraulic Mine, at the junction of the Little North Fork with the North Fork, is the principal one. Originally comprising two claims of 20 acres each, one is now worked out and the other partially so. The placer consists of from 3 to 20 feet of gravel, containing fine river wash gold, resting on a rough granite bedrock and overlaid with from 10 to 30 feet of red clay and granite sand. A ditch of 450 inches capacity brings water from Garden Gulch and Little North Fork all the year round, except when frozen up. It is used under from 85 to 150 feet head against the soft banks. No bowlders are found requiring to be moved by a derrick, but occasionally one is broken with powder. For mining, the water is held in a reservoir and a head of 800 inches used, 300 through a giant and the remainder as a ground sluice. The ground now being washed yields at the rate of $8,000 an acre. But little quicksilver is used, the gold being caught in the first twenty boxes from the head. A sawmill on the mine furnishes lumber for the flume and other ordinary purposes. Ordinarily three men are employed. The mine pays well and several years' work is still in sight.

The Olsen Hydraulic Mine, half way between Sawyer's Bar and Forks of Salmon, is similar in description of ground to the Ahlgren, but it is not as extensive, nor provided with as good a water supply. Three to four months' run is had with a full head of water, and the balance of the time a quarter head. Three men are employed.

Three miles farther down the river is the Austrian Hydraulic Mine. The area of the claim is small and the wash heavy, requiring powder and derrick. The ground mined is 20 feet deep. Probably 500 inches of water are used under 200 feet head for four or five months every winter. When running three men are employed.

The last of the four is the Shumway Hydraulic Placer, situated a mile above the Forks. It comprises 40 acres of high bar lying on both sides of the river and close to it. The water supply, maintained throughout the entire year, is taken from the North Fork and brought onto the ground with 80 feet head. For washing, a canvas hose and old-fashioned pipe are used. The wash is very heavy, requiring the constant use of the derrick to remove large rock. Two to four men are employed.

Unlike the portion of the North Fork above Sawyer's Bar, along which are many unworked bodies of auriferous placer ground that will pay to mine, the portion of the river below to the Forks is practically worked out and can cut no figure as a gold-producing section.

At Forks of Salmon, commonly known as Bennett's, there is a considerable area of unworked placer ground. It consists of the high bars and flats on the left hand bank of the South Fork, and both banks of the main river below the junction. These were left practically untouched by the early miners, there being no water available for mining. The wash is very heavy, from 20 to 40 feet deep. The dump is very small, hardly 10 feet, and the water supply inadequate without the construction of long ditches and flumes. The present owner of the properties, W. P. Bennett, has brought water in from the South Fork on the north side, carrying it across both the North Fork and the South Fork by high trestles and trusses. This supply is utilized by Chinese mining on the right bank on the main river below the junction. The head is, however, so small, that their operations are more in the nature of ground sluicing than hydraulicking. For the mining of the bar on the opposite bank of the river, the owners, Messrs. Smith & Bennett, have constructed a ditch from McNeal Gulch, bringing water in under 150 feet head for piping, and repairing another lower ditch from Knownothing Creek have obtained an additional supply for sluicing. It is expected to have the claim in operation in the winter of 1892–93.

Below the Forks, extending down the stream for about 5 miles, is a succession of bar and high bench placers that annually produce considerable gold, though as yet some of them are hardly opened for effective working on a scale commensurate with their extent. A few of the bars have been entirely worked off and have paid well. Others less advantageously situated with regard to water supply and dump, have been scratched around the river rim by the primitive pick and shovel methods of the early miners. The high bench claims were not discovered by them.

The Bloomer Hydraulic Mine, situated 5 miles below the Forks, on the left side of the river, comprises about half a mile of the old bed of the river, filled with 20 to 40 feet of gravel and buried under from 30 to 50 feet of red and yellow clays and hill soil. Altogether, there may be as much as 60 acres of workable ground. This old section of channel is about 200 feet above the present channel, giving ample hydraulic dump. Water for hydraulicking is brought through 3 miles of ditch from Nordheimer Creek. The quantity used is from 800 to 1,000 inches, and the season is four months. The ground washes readily, all going through the sluices. The gold is smooth, river-washed gold, averaging wheat-grain size, though occasionally a nugget is found and some flour gold. It is all caught in the upper boxes of the sluice, and quicksilver is used only to facilitate cleaning up. The force employed is two night men and three day men. The average season expense of opening and running is stated by the owner to be about $2,000, and the average output from $6,000 to $8,000. The area bottomed is up to the present time approximately 2½ acres and the total yield something over $50,000, which would give an average gold content to the ground of $20,000 per acre.

McNeal's Hydraulic Mine is situated just above the Bloomer, but lower down on the river bank. It covers 60 acres of a large flat. The

surface is from 50 to 75 feet above low-water level of the river. The depth of gravel is 30 to 35 feet, leaving only a small dump, the principal difficulty to contend with in hydraulicking. The wash, like that of all low bars, is heavy, largely cobbles and bowlders, and requires the use of both powder and derrick. The gold in the old channel in the bar is a bright and smooth scale gold, easily saved without quicksilver. On the higher portions of the bar, the rim of the old channel, the gold is coarser. Water is brought from Nordheimer Creek under 135 feet head. About 1,000 inches is used seven months each year. The ground so far washed off indicates a rate of gold content of about $8,000 an acre. The disadvantages of mining, however, keep the output down to about $2,500 annually. Three men are employed. The claim pays a moderate profit over expenses.

On the opposite side of the river, a little lower down, is the Sauerkraut Hydraulic Mine, now operated by Chinese. It is similar ground to McNeal's—not as extensive, but has a better dump. Water is obtained from Morehouse Creek. The claim is operated day and night during the season, eight men working.

Adjoining the Bloomer on the north, on the same level and precisely the same character of ground, is the Lew Williams Hydraulic Mine. It is operated on a very small scale, the owner alone working with a light hydraulic rig.

The Crapo Hydraulic Mine, next to the Bloomer the most important mining property of this locality, is situated on the right bank of the river, 3½ miles below the Forks. Messrs. Bennett & McLaughlin are the owners. Like the Bloomer, it is a high bench, once the channel of the river. It is, however, much higher than the Bloomer, being nearly 400 feet above the river. The gold-bearing gravel is from 20 to 25 feet deep, and is overlaid with from 20 to 60 feet of red and yellow clays. The character of gold is coarse, while that in the Bloomer is fine; the ground is not, however, as rich to the acre. The water supply—1,500 inches from Crapo Cañon—is the best in the locality; it is under 200 feet head, and lasts nine months. The giant being behind the sluices and driving to them, much more ground is handled to the inch of water than is the case in the Bloomer. The mine is worked night and day, three men being employed.

Immediately below the Crapo, on the river bank, a bar claim is being worked by ground sluicing, with fair returns to the two men employed. Between this point and the Forks are several low bar claims that will be worked with the water now employed on the Crapo, as soon as that claim shall be worked out.

On the South Fork there is less mining than on either of the other two streams noted. The area of unworked placers is, however, much more extensive. Insufficient dump for the lower placers, and insufficient water for the higher, have been the retarding influences on the mining of this section. At the present time, however, the greater area of the mining ground is in ownership sufficiently strong, financially, to construct the necessary ditches and otherwise prepare the ground for mining.

Almost at the very headwaters of the South Fork is the Summerville Hydraulic Mine, owned by Messrs. Campbell, Smith & Spooner, the latter being in immediate charge of the mining. What has been known as the Summerville claim proper is now about worked out, 13 acres

Gold Run. Both of the two working tunnels cut across 14 feet of hard silicious slate, then a soft blue gouge material, and then through 8 feet of hard silicious slate before the Gold Run vein was found. Working to the south on this last in the upper tunnel, the pay ore disappeared with the appearance of black slate in the hanging wall. About this point a prospect crosscut was made through the foot wall to the blue gouge, which was found replaced by a 6 or 8-foot ledge of high-grade quartz. From above the tunnel level 500 tons were taken out of this in raising 48 feet. Above it the upraise at 23 feet entered another mass of quartz of unknown extent, also high grade. At the time of my examination the lower tunnel was not sufficiently advanced to disclose its downward extent.

The pay shoot on the Gold Run ledge at the surface was 20 feet long. It has been mined out clear down to the upper tunnel level, 450 feet on the pitch of the vein, increasing in length with depth till at the tunnel level it is 110 feet. In the upper tunnel the length of pay shoot on the Hunter ledge is 80 feet. In the lower tunnel, though smaller, the pay shoot has lengthened to 150 feet. Ore on this vein has only been taken out for the 75 feet immediately above the upper tunnel. The ore is a hard quartz, carrying gold moderately coarse, so that the bulk of it is secured by battery amalgamation in the mill. The sulphurets consist of pyrite and galena for the most part, and carry sufficient gold to make its extraction profitable. In the mine sixteen men are employed. The cost of mining in the year 1891, including all dead work, was $12 per ton.

The ore is carted from the mine to the mill, a distance of half a mile. The plant consists of a four-stamp battery; weight of stamps 750 pounds, run by water power; the water, 25 inches, with a hurdy-gurdy wheel, under 325 feet head. Five tons of ore every twenty-four hours goes to the battery through an automatic percussion feeder. From 86 to 90 per cent of the gold is caught in the battery. The remainder and the battery sands pass through No. 12 angle-slot battery screens, over a plate 42 by 72 inches, and are discharged thence into one of four pulp tanks for treatment by the McArthur-Forrest cyanide process. At the date of my examination this process had just been introduced, and the first run was being made with it. Concerning its results no certain statement could be made, though the millman and assayer were well satisfied with its working up to that time. Theoretically, as applied in this mill, the process is perfect. The battery pulp discharges into the top of one of the four pulp tanks 4 feet deep and 6 feet in diameter, till the tank is full of pulp, the overflow meanwhile going off from the top of the tank to a fifth tank of the same size, called the sump tank. In the sump tank a further settlement of the slimes takes place, to be drawn off from the bottom, as they accumulate, into a sixth tank, called the slime tank. The water is pumped by a centrifugal pump from the sump tank to two battery tanks, from which it again goes to the battery and the round of tanks, being used continuously. The pulp tanks have false bottoms, arranged as filters. The pulp is allowed to settle on the filter without other agitation than that furnished by the inflowing stream. Once full of pulp the stream is turned into another tank. At the bottom of the full tank a cock is opened, and the surplus water, filtered through the false bottom, is discharged. When no more water drains off, a solution of cyanide of potassium is pumped into the tank, till

the pulp is covered about 4 inches deep. This solution has a strength, in cyanide, ranging from thirty-three to fifty hundredths of 1 per cent. As it filters through the pulp, dissolving the fine gold, it drives the remainder of the battery water in the pulp in advance of it through the filter. Properly manipulated, there is no mixing between the water and the added cyanide solution, and the water is allowed to flow away till it begins to show traces of the cyanide. The flow from the cock, being the enriched cyanide solution, is then turned into a trough, through which it flows to the precipitating boxes (8 inches square and twelve in number, filled with zinc shavings). Here, the dissolved gold having been precipitated, it flows to the cyanide solution tanks, two in number. In these last the solution is tempered to the required strength from a standard solution, and is again ready for another round through the tanks. As a rule, at least four solutions are put through a tank of pulp before an assay is made of the treated pulp. So far as such assays had been made at the date of my examination, they failed to give assay buttons that could be weighed, showing a practically perfect working of the process. It will be noted that the manipulation is such that there is absolutely no opportunity for gold to escape, unless in the tailings after they have been treated to the cyanide process and assayed. Should the assay show a measurable amount of gold, other solutions are added till the assay shows only a trace not weighable. Some of the details of the process, it is stated, have been modified by the particular experience had. For example, the cyanide solution does not go through the battery at all, so that possible effect on the quicksilver is avoided, the theory being to get all out of the ore by direct amalgamation that is possible before giving the cyanide treatment. Undoubtedly a saving of cyanide is made in this way, as its action is confined to dissolving only the very fine gold, either free or combined with minute fragments of the sulphurets. The entire cost of milling, including this treatment, is stated to be $6 a ton. The ore of this mine is all high grade, milling from $50 to $120 in the battery and $10 to $33 in the tanks to the ton.

Two miles down the ridge is the Hansen Quartz Mine. At the date of the examination and for some months previous only prospecting work was being done. The vein is small.

The Knownothing Quartz Mine, owned by Hansen & Bennett, is situated on the mountain slope, directly below the Gold Run group, on the North Fork of Knownothing Creek. It has been, a few years back, quite a gold producer. The pay shoot has, however, been lost, and at the present time operations are confined to the work of two men prospecting.

Northeasterly from the group of mines described (a gap of 5 or 6 miles, in which no gold-bearing quartz ledges are known to exist, intervening), a group of small ledges is found on Methodist Creek. These were prospected to a considerable extent a few years since, but failed to develop anything of value. At the present time nothing is being done on them.

Another gap in which there are no known gold-bearing veins, and at the head of Black Bear Creek, 8 miles southwesterly from Sawyer's Bar, is the Black Bear Mine, owned by ex-Lieutenant-Governor John Daggett, the most celebrated mine in Siskiyou County, and one which has added largely to the gold product of the State. The present workings are at the north end on the adit level, on what is known as the

Yellow Jacket claim. Stopes are being opened on two veins parallel to each other and other development work being done in the way of levels and crosscuts to determine the extent of the ore bodies. The trend or strike of the pay ore bodies that have been mined out being on a flat angle northerly, it is probable that the apex of entirely new bodies of pay ore has been found, and there is every reason for believing them as persistent downward as the others proved to be. For the deep mining the old shaft, 600 feet down from the adit level, can be utilized. The present condition of the mine justifies the opinion that it will again become a bonanza producer.

Crossing the divide between Black Bear and Eddy's Gulches, hardly distant in an air line 1 mile from the Black Bear, is the southern end of quite a group of veins lying at the head of Eddy's Gulch, on the slopes from Ball Butte. They are from 4 to 5 miles from Sawyer's Bar by trail.

The Gold Ball Consolidated Mining Company (incorporated) owns six locations, covering 8,000 feet of lodes, including the Klamath and Mountain Laurel, the latter of which is the only one being operated at the present time. The country rock formation is a black talcose slate, very much contorted and broken by faults. It is crossed and cut up by trap dikes very silicious in character. The course of the vein is, as near as can be determined, north 20° east. It lies very flat, making its mining very similar to that of drift mining. In thickness the ledge varies from a few inches to as much as 30 feet. The working openings are three tunnels, two on the upper level and the third 65 feet lower, vertically, but giving from 225 to 300 feet additional backs for drifting out. The upper tunnels cut the ledge close to the surface. The lower tunnel is 600 feet long, through a hard silicious slate much of the distance. The trend of the pay ore bodies is to the north, on about the same flat angle as in the Black Bear. It seems probable that the entire ledge, close to the surface, has been broken over and flattened from an originally much greater pitch. The rock over it keeps working and swelling, necessitating very heavy timbering. The ore is trammed to the mill, a distance of about three quarters of a mile. The plant consists of twenty stamps, weighing 650 pounds each, in four-stamp batteries. Power is steam in summer and water in winter. The mill is old and hand-fed, and crushes only 1 ton to the stamp every twenty-four hours. Sulphurets are saved by a Victor concentrator. The percentage is said to be from 1.5 to 3.5. No systematic effort has been made to treat them on any extensive scale. The ore at times has been very high grade. The force employed consists of seven white men and twenty-one Chinese. It was the largest number employed by any mine in the district at the time of my examination. At the time of my examination a change in ownership was pending and many improvements projected.

Westerly from the Gold Ball properties to the Portuguese Quartz Mine there are numerous parallel ledges, most of them small, some of them more or less mined, but none of them being worked at the present time. The Live Yankee is probably the most noted of them in point of gold yield.

The Ampback, Portuguese, or Fagundes Quartz Mine, as it is variously known in the locality, is situated on a sharp ridge lying between two forks of Eddy's Gulch and on the western edge of the group. It is worked through six tunnels, all of them short. There appear to be at

least two ledges, both small and irregular, but so distinctly continuous as to be readily followed. The quartz near the surface and above the water-level is considerably decomposed. All of it is found to be rich in gold, and milling it has returned from $30 to $200 a ton. About one half ton to the hand is the daily product, eight men being employed in the mine. The timbering required is light. The ore is all sacked and hauled to the mill at a cost of $1 per ton. The plant consists of a five-stamp (750 pounds weight) battery, the heaviest plant in the district. With a No. 7 slot screen, the gold being coarse, it crushes 8 to 10 tons every twenty-four hours. It is run by a 3-foot Pelton wheel, in the winter only. The plant as a whole is the best in the district. During the last two years the mine has been the largest producer and the most profitable in the district.

North of the Gold Ball properties, and high up on the summit of a northern spur of Ball Butte, is the Uncle Sam Quartz Mine, owned by Edwin and S. I. Sheffield. Its course is the prevailing one of the belt, and all the more important veins in it being approximately north 20° east. The dip is fairly regular 60° to the southeast. The ledge is a strong one, varying from 18 inches to 12 feet in width, and is not broken by faults. It is working through tunnels, of which there are five. In addition to considerable ore left above the 300-foot tunnel, the ground from that down to the 500-foot is practically unbroken. The owners claim that the best ore they have yet found in the mine is on the 500-foot level. The ore is carrying a large percentage of sulphurets with increased depth; on the 500-foot level from 3 to 5 per cent assaying high. The milling plant consists of two batteries of four stamps each, run by water power about six weeks every spring. The ore is said to yield free milling $18 to $20 a ton.

East and northeast of the Uncle Sam, and adjacent to it on the head-water ravines tributary to White's Gulch, Golden & Eveleth have a number of promising prospects, on which they have done some surface work. From one of them they had 85 tons of surface ore milled in the Uncle Sam mill, which yielded $14 62 a ton. The ledges are large and can be opened by tunnels very inexpensively. Lower down on White's Gulch some other discoveries of quartz have been made that were prospecting very favorably at the time of my examination. This locality, White's Gulch, I regard as very promising for development work. The ledges are both large and numerous, judging from the amount of float quartz in the surface soil.

CALLAHAN'S RANCH.

Mining in this district is exclusively placer, and is confined to the bed and bars of the South Fork of Scott River. In former years the main Scott River below the junction of the South and East Forks at Callahan's was mined for 2 or 3 miles, and considerable gold taken from its channel and high bars, but the latter are now worked out, and the gold in the river channel is at such a depth that it cannot be profitably mined. On the South Fork about twenty white miners and fifty Chinese are engaged in mining, the former in small claims in the gulches and high bars, and the latter in about half a dozen claims in the bed of the river and hydraulicking in one of the high bars. The output of the district averages $75,000 annually.

The largest gold producer is the Montezuma River claim, situated about a mile southwest of the town of Callahan's Ranch. For three years it has been in Chinese ownership, and has been very profitably operated. The flow of water in the river being comparatively small, only a light rig is required for the operation of the mine, and it can be worked almost continuously through the entire year. During the year 1893 the weekly clean-up ran from $500 to $4,000. The exact figures of total production could not be ascertained, but for the year is not less then $50,000.

Adjoining the Montezuma, up the river, are two more river-bed claims, operated by Chinese with apparently satisfactory results. One of these employs ten men and the other four. On the south side of the river, opposite Hellmuth's store, 3 miles above Callahan's, is a Chinese hydraulic claim operating in a high bar. The area of ground is limited, and the pay is not very large, the mine having been drifted. Ten men are employed. In addition to the preceding there are three small Chinese claims, employing two or three men each.

The only new mining operation in the district is the projected opening of a hydraulic mine on Jackson Creek, one of the headwater streams of the South Fork, 7 miles above Callahan's. Messrs. Stern & Myers have acquired a number of claims covering the channels of Jackson Creek and Little Jackson Creek, and propose to work them by hydraulicking. They have built a ditch half a mile long, and put in place 750 feet of 15-inch pipe, and rigged up to commence work in the season of 1893. During the year sixteen men have been employed.

QUARTZ VALLEY.

This district occupies what may be called the northwest corner of Scott Valley, though separated from the main valley by a low mountain ridge. Its placers are very extensive and rich, and there are a number of small quartz veins being developed that may prove permanent and profitable producers.

The placer mines are of two distinct kinds. At the upper or southern end of the valley, in the claim of the Stockton Gravel Mining Company, the placer is a drift mine on a flat, nearly level bedrock, without defined channel rims, covered with from 60 to 100 feet of soft pebbly gravel and alluvium. The gold is all coarse, water-worn channel gold. In appearance it is similar to the placer gold mined at Scott Bar, and to that taken out of the placers at Etna Creek. Clearly not in its original place, its source is probably the gravels of an old buried river, traces of the channel of which are observable in Douglas Hill, just south of the mine, and in benches on the west side of the valley north of where Shackelford Creek enters it. Other traces of this old channel are found on the western edge of Scott Valley as far south as Callahan's. The main placer deposit of the valley, however, lies on the eastern side. It is the result of the direct erosion of the ferruginous limestones that compose the western slope of the mountain separating Quartz Valley from the main Scott Valley. For a distance of 4 miles these limestones are seamed with auriferous quartz veins. On the eastern slope of this mountain only one ravine seems to have eroded deep enough to get to the gold-bearing rocks, but on the Quartz Valley side there are four such ravines and a resultant area of placer ground of 650 acres lying

between the outcrop of the country rock on the mountain slope and the eastern edge of the valley bottoms. It is of course possible that these placers extend out into the valley underlying the sandy alluvium, but no determination of the fact has been sought as yet. These placers consist of uncemented angular fragments of the country rock and quartz, with sand and clay, in depth from 1 foot to 30 feet, covered with a deposit of clay and surfaced with alluvium. Where shallow, in the heads of the four ravines and well down toward the main valley, they were worked out by the old miners, but the deeper deposits were left untouched, owing to the insufficient dump and drainage. The gold is generally fine, though coarse pieces are found, and is generally rough and angular, though occasionally a smooth piece of gold and quartz combined will be found. At the present time all the placer mining ground of known or presumed value is consolidated into two ownerships. What is known as the Stockton Gravel Mining Company is in possession of the entire upper end of the valley with its coarse gold placers, and the R. H. Campbell Gold Mining Company (limited), an English corporation, owns all the other placers at the lower end of the valley.

The Stockton Gravel Mining Company (incorporated) is mining its placer ground by drifting from shafts. As already noted, the gold is on the bedrock. The method of mining practiced is as follows: The bedrock being very flat, and there being considerable water to contend with, a drain tunnel, now 8,000 feet long, has been constructed from shafts 300 feet apart and ranging in depth from 50 to 125 feet. Its contract cost has been $1 12½ per foot. From the bottom of a shaft where this tunnel enters the pay lead, drifts are run off and the lead followed as closely as possible. There being no defined rims of bedrock, this is done by prospecting the gravel from time to time by washing loads separately, and by following its general direction as determined by the worked-out portion. The depth of the gravel taken out is 4 feet, and with it 1 foot of the bedrock is taken. As soon as the drift extends 300 feet from the shaft, a new one is made and used as a base for the continuation of the work. About 25 or 30 feet width of ground is breasted out; half of it as the main drift or gangway is pushed forward and the other side is working back to the shaft. The ground requires considerable support from timbering. Round pine is used, and sets are placed 4 feet apart and 6 feet center to center. The shafts not being deep (50 to 60 feet), the hoisting rig is of the simplest and cheapest description. A whip, hemp rope, and horse-power whim under a shed constitute the entire plant. From the breasts the gravel is loaded into tubs set on small platform cars, on which they are wheeled to the shaft. In winter, when a water supply can be had at the shaft, the gravel is washed there. In summer it is hauled in carts to a ditch half a mile distant. The pay is not at all regular, sometimes $2 50 or more a tub and frequently nothing at all. The force employed consists of the Superintendent, foreman, and teamster (white), and ten Chinese underground men, worked in two shifts, day and night.

The R. H. Campbell Gold Mining Company (limited) is the successor of the Quartz Valley Mining and Stock-raising Company. In addition to the 650 acres of placer mining ground already described, it owns 850 acres of land covering the bed of the main watercourses of the valley, Shackelford and Mill Creeks, for dump, the junction of Shackelford Creek and Scott River as a site for the entrance of a drain-

age tunnel, and the heads of the ditch on Shackelford Creek. Besides these real properties the company owns appurtenant to them all the water rights of Shackelford and Mill Creeks and four ditches bringing the water onto the mining ground. Possessed of an ample working capital, it is the intention of the company to open up a mine on a scale commensurate with the magnitude of the property. As already noted, the higher and shallower portions of the mine have been worked by the old miners and by the predecessors of the present company by ground sluicing and hydraulicking, the latter at one point assisted by an elevator. A considerable area, however, can still be effectively worked by hydraulicking, particularly in what is known as the Hull Gulch claim, the farthest up the valley. The area worked off by hydraulicking during the present season, the depth of ground being about 35 feet, paid at the rate of $25,000 an acre. This rate of pay had been previously realized from the hydraulicking of several acres in the Sucker Flat claim in the next ravine to the north. Though there is some fine gold throughout the entire mass of the ground from the surface down, the greater portion is concentrated close to and on the bedrock. This seems to be more noticeably the case as the depth of the wash increases, and has been verified by the results of the washing of gravel from shafts sunk to test the ground for drifting.

This last is the method necessary to be employed for the exploitation of by far the greater extent of the placers. Drainage, the serious problem of all drifting from shafts, necessitated in this case by the plain, light slopes of the valley, is to be accomplished by a tunnel run from the junction of Shackelford Creek with Scott River. The cheapness and ease of construction obtained with the Stockton Company's tunnel at the head of the valley can be duplicated with this. The length to Pioneer Gulch, the lowest of the veins of the property, will be 600 feet; then for 10,000 feet the tunnel will run in the lowest depression of the pay lead and prospect the ground as well as drain it. A prospect shaft to test the value of the ground for drifting was put down in Sucker Flat Gulch claim in 1891. From this shaft, just 100 feet deep, several drifts were run. From them 4 feet of gravel was taken out and washed, paying at rates from 50 to 80 cents per square foot of bedrock.

As the shaft seemed to be on the rim of the pay channel, a second shaft was put down at another point in 1892. Bedrock was reached in 120 feet. The gravel from the bottom of this shaft, 4 by 8 feet, paid $25, or at the rate of 78 cents to the square foot. At the date of my visit and examination, drifts were being run from this shaft and preparations were being made to put down a third shaft in Pioneer Gulch to prospect the lower end of the ground. The drain tunnel once constructed, thus doing away with the necessity of pumping water, the cost of mining, including the opening of new shafts as the workings extend, will be very small, probably not exceeding, with economical management, 25 cents per square foot of ground drifted.

Power for hoisting will be obtained by utilizing the fall of Shackelford Creek above the diverging points of the ditches. Electrical transmission will make it available for use at the several shafts, and will also furnish illumination underground and for the hydraulic pits at night. To maintain the water flow during the dry season, water will be stored in two lakes at the head of Shackelford Creek. With dams an aggregate storage of 120,000 miner's inches will be secured.

The quartz veins in this district are numerous and all of them carry more or less gold. The quartz mines, however, are few in number, as the veins are small, and as a rule carry the gold in pockets very much scattered and hardly justifying the necessary expenditure to find them.

The Green Mountain Quartz Mine is the principal one at the present time. It is situated on the slope of the mountain just north of the Hull Gulch claim of the R. H. Campbell Company. The vein varies in width from 4 to 16 inches, averaging in the pay shoot about 10 inches. The length of the shoot has steadily increased with depth. At the surface only 40 feet, it is at the adit level (fourth) 152 feet, and on the fifth level 80 feet, down the winze from the adit level 216 feet. A second shoot of ore 150 feet long has been opened in the adit level, but not stoped as yet. The main shoot has been stoped out from the adit level to the surface, 450 feet, and is being followed down by a winze from the adit 750 feet in from its entrance. This winze is now down 160 feet. For mining there is an excellent plant. The average yield of the ore is stated to be $45 a ton; the product for the six months, March to August, 600 tons milling that figure. The ore is hauled in wagons to a custom mill at Oro Fino. The cost of hauling is $1 a ton, and of milling $2 25. Employed at the mine are one foreman, one tool sharpener, four engineers—two for the compressors and boiler, who do their own firing, and two for the hoisting engine in the mine—eleven miners, and two carmen. This large force and the expense of operating the steam plant, coupled with the smallness of the vein, makes the cost of mining very high.

Northerly from the Green Mountain is situated the Tiger Quartz Mine. It is in the same limestone formation as the former, but is a smaller ledge, being only 6 inches wide. The pay shoot, 40 feet long, is worked to a depth of 100 feet, and the ore milled in arrastra pays $15 a ton. Two men, the owners, work the mine when not employed for wages in other mines.

There are one or two other ledges of similar character and extent worked by the owners, but none so far that promise developing into more than wages claims for a few miners. The ores are milled in arrastras, run by water power. The Johnson Quartz Mine, situated at the south end of the mountain, on the Oro Fino side, has not been worked for several years.

ORO FINO.

A small ravine tributary to Oro Fino Creek from the mountain separating Quartz Valley, eroding through the non-gold-bearing rocks that form the western slope into Quartz Valley, has formed the placers of Oro Fino. Limited in extent to this one ravine, though originally very rich, they are now very nearly worked out, and mining operations are confined to two hydraulic claims—Eastlick Bros. and Wright & Fletcher. Both claims are worked by elevators, the natural dump being insufficient. The water supply, though considerable in quantity, is under comparatively low pressure for elevator work, so only small areas are washed each season of three to five months. At present the elevators have a lift of 25 feet, but this is being constantly increased, as the direction of the workings is down the channel. The ground is rich, paying 88 cents to the square foot of bedrock cleaned, but the disadvantages of working are so serious and increasing that it is not probable that mining can be continued for many years to come. Though it is probable

that there is in the bed of Oro Fino Creek considerable placer gold, no effort has yet been made to obtain it. The difficulty to be contended with is lack of drainage.

KLAMATH RIVER.

The drainage of all the auriferous area of Siskiyou County ultimately finds its way to the ocean through the channel of Klamath River. It is a crooked, torrential stream, with tremendous flood stages, and a volume of flow only exceeded in the State by the Sacramento. From Cottonwood Creek to the mouth of Salmon River, a distance of 140 miles by the meanders of the river, the fall is, in round numbers, 1,700 feet, an average of a little over 12 feet to the mile. This is the auriferous portion of the river in Siskiyou County. In the immediate cañon of the river the deposits are practically all placers. The only quartz that I learned of was a blanket ledge, very much decomposed and lying exposed on the surface, situated on the north bank of the river, about a mile below where Ash Creek comes in. This was discovered in July, 1891, by following up float found in a river claim. Since that time over $10,000 of gold has been literally picked up on the surface, some of the chunks being very large, one $500.

The placers are the river bed for many miles, drift diggings in a few of the bars, notably at Hamburg Bar, below the mouth of Scott River, and hydraulic placers, principally in the benches, some of them as much as 500 feet above the present river bed. These bench deposits are most extensive and characteristic in the vicinity of Happy Camp, though scattered along the river from Hamburg Bar to Salmon River. The gold in appearance is very uniform, being a fine scale gold, smooth and water-worn. There is very little flour gold, and only a few claims produce nugget gold. One of these is a small hydraulic mine, just below Hamburg Bar, where the gold is in appearance similar to that mined at Scott Bar, on Scott River. Another is the upper end of the auriferous portion of the river, at the mouth of Cottonwood Creek, and below where the blue gravel channel is cut by the Klamath River, the source of the coarse gold being undoubtedly the blue lead channel. The bed, bars, and benches of the Klamath River in the aggregate of forty years of mining have yielded an enormous amount of gold, and much yet remains in the unworked ground.

The source of this gold, like that of many others of the California rivers, is not immediately adjacent. The river cuts across the main gold-bearing rock belt of the county, but that portion of it is not known to contain gold-bearing veins, the exceptional instance being noted above. The blue lead channel, near the junction of Cottonwood Creek, is only cut off for less than half a mile, and erosion has taken place to so slight a depth below its old bed as to preclude the idea of any gold derived from it having traveled far down the river. East of Cottonwood Creek no gold is found in the river or any of its tributaries. Generally where the river finds its bed in the slates, the latter are full of seams and masses of quartz, which, however, are not gold-bearing.

It is almost a certainty that the great bulk of the gold in the main river placers comes originally from the erosion of certain of the tributaries which cut the gold-bearing belt where it was rich in gold-bearing quartz veins. These tributaries are Shasta River, Humbug Creek, Little Humbug, Scott River, and Salmon River on the south, and Cotton-

wood, Beaver, and Indian Creeks on the north. Of these last three, Cottonwood Creek derived its gold from the erosion of the blue lead channel which lies west of it at a slightly greater elevation, and Indian Creek from the most westerly of the gold-bearing rock belts of Northern California, elsewhere more particularly described.

As compared with the other rivers of the auriferous regions of the State, the erosion of the Klamath has undoubtedly been coexistent with that of the present channels of the Feather, Yuba, and American, as distinguished from the period of erosion of their now drift-filled and lava-capped channels. The blue lead channel of Siskiyou, referred to as being crossed by the Klamath just below the junction of Cottonwood Creek, is likely the contemporary of the oldest of the latter, if, indeed, more complete investigation shall not demonstrate it as even older.

In Humbug Creek the placers are continuous from the river up to the quartz veins that undoubtedly formed them. Salmon River is similar in this, except that the placers have not been as rich, nor as continuous. Scott River, on the contrary, has tributaries that contain very extensive and rich placers. but the main river itself, except for the last 3 or 4 miles above its junction with the Klamath, and for the most part below where Mill Creek comes in at Scott Bar, has no placers. The South Fork nas the Callahan's Ranch placers. All of the tributaries from the west have some gold; Oro Fino and Shackelford Creeks have very rich placers close down to their junction with the river, and on the eastern side of the valley, Indian and McAdams Creeks have equally rich and extensive areas of placers.

Reference has been made, in connection with the Quartz Valley placers, to the evidences of an old channel on the west side of the valley carrying coarse, river-washed gold. At several points above the present channel of Scott River, I am advised that small areas of similar wash remain, indicating the continuity of this channel toward Klamath River. It is, however, a singular fact that neither Scott River nor its western side ravines and cañons between Shackelford Creek and Scott Bar have any placer deposits. The conclusion is almost a certainty that the gold in the placers of Klamath Cañon, in Siskiyou County, came from Humbug and Little Humbug Creeks more largely than from any other source. Next to them in importance as contributing streams were Shasta and Scott Rivers and Indian Creek on the north from the Siskiyou range.

The bench placers present very interesting phenomena of the erosive action of water. It is noticeable that they lie on soft rocks as compared with the inclosing rocky walls of the narrow cañons immediately below. But the bedrock levels of the benches and of the present river beds in those portions of the river flanked with benches are regular, and have less than the average mean fall as compared with the portions of the channels in the precipitous cañons. The explanation is in the more rapid erosion of the softer rocks flattening the channel grade, which causes it to fill with drift gravels in flood stages; these latter in turn accumulating, turn the erosion of the river into a new channel on the one or the other side of the first one; this new channel, in its turn becoming flat and filling at a lower level as it catches up with the slower erosion of the hard rocks of the cañon below, is again left on one or the other side of a new channel. This is the geological process, indefinitely repeated, of the formation of the high benches and wide

bars of auriferous gravels. They are simply parts of the filled-up bed of the river as it existed during a portion of the vast interval that has elapsed from the time when the recession of the glaciers northward left the running waters to work the glacial scratches on the folded rock strata into grand cañons and fertile valleys.

On the Klamath there has been no interference with this gradual process of erosion by cataclysmic volcanic action. No vast lava flows have filled the channels and turned the flowing waters miles away. The general tendency of a torrential river channel is to become shortened up as its erosion cuts deeper into the rock. The lessening grade diminishes the velocity and carrying power of the water; the channel fills up with gravel and sand until the water is finally forced out of its bed, and naturally takes that side of a mass of drift that will give it the most grade. The high benches are therefore found on the long side of the bends, the formation of the river bars going on the short side of the same bends.

At Happy Camp the conditions of bench formation were particularly favorable. For about 10 miles the river runs through comparatively soft slates, above and more particularly below which are hard belts of rock, very resistant to erosion. Slides have, of course, had a certain amount of effect in burying sections of the river channel and forcing it to cut a new bed. Hamburg Bar is a marked example of this. Underneath a mass of unbroken, unstratified material there is an old channel of the river on about the same level as the bedrock of the present channel. The gold all seems to be carried in the old buried channel, which pays very well by drifting, while the present river bed has been found unprofitable to mine. The slide, when it occurred, formed a dam, over which no gold could pass till it had been cut down to the level of the buried channel. I observed two instances in which there lay between the old channel and the present, high hills of country rock. One of these was at the Doolittle Hydraulic Mine, 10 miles down the river from Happy Camp, and the other on the opposite side of the river, about 5 miles above Happy Camp. The latter was covered with auriferous gravel, which had been mined off profitably. A similar example to this last occurs on the Trinity River, a few miles above Junction City.

River mining on the Klamath is followed from about the mouth of Shasta River to Hamburg Bar. The claims are not as numerous as in former years, much of the ground being worked out and abandoned. Sixteen were being operated in 1892, all but six being Chinese companies. At the time of my examination on the ground nearly all of them had the rigs in place and were taking out gold, though considerable difficulty had been experienced through the variable flow of the river, occasioned by logging operations in the upper river. The damming employed to hold the water for booming left too little water flowing to properly operate the wheels employed for pumping and hoisting, and at other times sent so much down as to endanger the safety of the wingdams. The method of mining is the same in all the claims. Wingdams are built of rock-filled cribs of poles, and faced inside and outside with inch planking. From 10,000 to 30,000 square feet of the river bottom is inclosed with these and cleared of water. A pit is sunk in this exposed river bottom; the top rock and sand containing no gold are removed by derricks down to pay gravel, on and close to the bedrock usually, and the latter is then washed and the gold obtained.

Three current wheels are usually employed: A pump wheel, operating a Chinese or rotary pump; a bull wheel, which furnishes power to the hoist of the derrick; and a water wheel of much greater diameter than the others, rigged with buckets, which it lifts full of water to the head of the washing sluices. Occasionally the latter wheel is not necessary, water being taken directly from the river into a ditch and conducting it to the sluice. The fitting up of a claim, labor and material, costs from $2,500 to $5,000, and for the most part has to be all done anew for each season's work, though occasionally some of the plant is taken out of the river and above high-water mark before the flood stages of the river come and wash everything out.

Each claim employs from ten to forty men, working in two shifts, night and day. Pitch pine is employed for lighting the mines at night. The total expense of fitting up and operating each season is from $5,000 to $8,000. As a rule the claims pay this back and something more in the way of profit, with a chance always of finding one of the very rich spots in the river from which the lucky miners may take out a fortune in a season's work. The Chinese are more and more acquiring a monopoly of this branch of the mining industry through purchase or lease of the claims from the white men. In all the claims working during 1892 the aggregate employment of men is not over three hundred and fifty, of which two hundred and seventy-five are Chinese. The production cannot be estimated with any certainty of accuracy, as the Chinese will not disclose what they are taking out. In my opinion, however, $225,000 is close to the actual figure.

Of the river mines, the McConnell & Quinn, just below the junction of Humbug Creek, has been continuously worked for fourteen years, and at the present rate of working can be depended on to last twice as many more. In this it is exceptional, as most of the claims are small, and become worked out in a few years. The claim covers 40 acres of a large bar and the adjacent river bed, of which the result of fourteen years' work has only been to mine out thoroughly a little over 2 acres. This has yielded in round numbers $300,000. At the time of my examination gold was being taken out at the rate of $1,000 a week, against an expense account of $350. In this claim the gold is almost entirely found in the gravel, very little being taken from the bedrock. Two derricks are used, and the gravel is worked off in two benches. For lighting at night a two-light arc dynamo is employed, run by a bull wheel set with the others in a large raceway carrying most of the river water. It is found much more satisfactory and economical than the common method of employing fires of pitch pine. On this claim forty Chinese miners are employed, and two white foremen.

Adjoining the McConnell & Quinn, and located in Humbug Creek just above its junction, is the Spangler Bros. & Co. bar claim. It has been worked by the same company in the old-fashioned, '49 style for twenty-five years, and still contains much unworked ground. The rig is of the simplest description, the derrick being operated by hand power. It is, with the exception of two small Chinese claims, the only placer claim being worked in Humbug Creek.

Between the mouth of Humbug Creek and Honolulu, 4 miles down the river, there are, besides the McConnell & Quinn Mine, three Chinese and one white company operating. Immediately below Honolulu are one white and two Chinese companies. At no other point are there as many river mines close together.

Between the mouth of Scott River and Hamburg Bar, about half a mile above the latter place, is a river mine being opened by Mr. Andrews. It is the lowest on the river. Thirty men are employed.

Hamburg Bar is the only point on the river where there is any drift mining. For over a mile on the left bank there is an old channel of the river buried under a heavy slide. The upper portion was mined out some years since, but the lower portion still contains unworked ground, now held in two claims. The bed of the old channel is as low as the present channel; so it is reached by inclines driven down from about the high-water line of the present river. Of the two claims the Mapleson was the only one being worked at the time of my examination. The power for drawing the cars of loaded gravel out of the incline and for running a Chinese pump is furnished by a 6-foot hurdy wheel, run by a small stream of water under 120 feet head. The mine is very wet and the ground heavy, requiring considerable timbering. Working down stream a breast 40 feet wide is carried, and up stream 30 feet. The gold is found not only on the bedrock, but high above it, 10 feet being taken out in places. Four men work in the mine during the low-water stages of the river.

Hydraulic mining is still an important industry on the Klamath, though it is not carried on as extensively as four or five years since. Between Hamburg Bar and the mines close to Happy Camp, there are six small hydraulic mines being operated, four on the left side of the river and two on the right. They are supplied with water from small creeks tributary to the Klamath, adjacent to the mines. The supply is sufficient only for a few months every year, and the area and richness of the ground hardly justifies the large expenditure that would be necessary to materially increase the quantity. All are profitably operated in a small way, and employ from three to five men three to five months every year. The owners are residents of the locality, and combine the two occupations of mining and farming.

The Happy Camp country I consider as including the mines for 4 miles down the river and 6 miles up stream. Here the terrace or bench formation of Klamath Cañon is developed to its greatest extent, the meanderings of the river widening it into flats and gentle hill slopes composed of auriferous gravels covered with a rich alluvial soil. These terraces or benches are found at elevations above the present channel of the river ranging from 50 to 500 feet. Their aggregate extent is an acreage well into the thousands. For mining them the hydraulic method is the only one practicable. The gravels are not deep, do not require much power to break them, and with their covering of 20 to 50 feet of clay and soil, wash readily. As a rule they have not been found rich enough to drift, though a few claims so mined have paid well. Hydraulicked, the acre yield seems to average close to $15,000, occasionally going as high as $20,000 and $25,000, and as low as $8,000. With an abundant and cheap water supply this rate of yield is quite profitable. At the present time large areas are becoming concentrated into single ownerships to limit the mining and decrease the population supported by it. A more serious cause of the present depression of this branch of mining is in the water supply. Never very large, it has been still more limited by the destruction of the ditches and flumes by the floods and snows of the winter of 1889–90, and subsequent neglect to repair and use them. In their present condition the expense of repairing

would be equivalent to an entirely new construction. This the owners of the mining ground hesitate to do, and meanwhile mining is dependent on the small supply of the ravines and gulches close at hand. Abundant supplies of water can be had from Indian, Thompson, and Elk Creeks. Eventually they will be utilized, for there still remain enormous quantities of gold in the gravel benches that can be profitably worked. The Chinese here are slowly but surely acquiring the desirable mining ground, as the white owners become discouraged and sell cheaply. They are extremely safe buyers. They invariably purchase on contracts, enabling them to mine the ground and pay for it as they take out the gold. If the ground fails to pay, it goes back into the hands of the seller, though this rarely happens, the judgment of the Chinese as to value being as safe usually as their business sagacity.

At Happy Camp a Chinese company, Ock & Co., now own all the ground on the west or right bank of the river below the town, a frontage of 3 miles, and an additional considerable frontage above the town. With it they own the largest water supply and other water rights and ditches, which, repaired, will enable them to mine on an extensive scale. At the present time they are running a pit which is paying at the rate of $15,000 to the acre. They also own and work the largest ranch in the section, and operate a sawmill to supply the lumber needed.

The Reeves, next to Ock & Co., are the largest owners of mining ground, controlling 4 miles of frontage on the same side of the river and above Ock & Co. Their water supply is, however, very limited, and cannot be increased, except by the construction of new ditches from distant sources, requiring a considerable investment. On the opposite side of the river very little mining is now being done, the destruction of the ditches two years since being more complete than on the Happy Camp side. The mines have been very rich, but they are more worked out than on the Happy Camp side.

Indian Creek, adjoining the Klamath at Happy Camp, is a considerable stream, and has been the source of a large gold yield. At the present time, however, only three mines are being operated. They are situated about 16 miles from Happy Camp. All are hydraulic mines, moderately profitable. The ground worked, Classic Hill, is similar in character to the Quartz Valley and Oro Fino placers. One claim is washing a soft rock in place, containing rotten quartz seams carrying gold. Down the river from Happy Camp to the mouth of Salmon River, at intervals of every few miles there is a bench of gravel containing gold. On these hydraulicking has been going on for the last thirty years. Though none are what could be called large claims, they are all productive, and taking the average of years, moderately profitable. Only accessible by trails, the rigs put on them are necessarily light. The water supply comes from adjacent ravines and gulches. The most noted of these claims are the Bunker Hill and Wingate Hill, the latter now nearly worked out. Adjoining the Wingate is the Doolittle claim, on which very little work has been done, principally prospecting. An excellent water supply is available from Clear Creek. The claim is exceptional, in that the quartz seams, of which the bedrock is filled, apparently, are auriferous. The washing of the few feet of soil off of the hillsides yields considerable quartz gold.

The hydraulic mining industry of the entire lower Klamath in Siskiyou County employs in the aggregate not more than one hundred and

fifty men for four or five months in the year; of these, at least one half are Chinese. The annual production, estimated, is somewhere near $120,000. This is very much less than a few years since, but the decrease, as already pointed out, is due, not to the working out of the mines, but to the temporary impairment of the mining plants.

HUMBUG CREEK.

Humbug Creek Mining District is exclusively a quartz mining district, and is situated in the headwater forks and cañons of Humbug Creek, on the northeastern slopes of Old Baldy. By wagon road, the mines are distant from Yreka from 16 to 20 miles. The first quartz mining in the district was carried on in 1854. Since then, and down to the present time, there have been periodical attempts to develop the industry. These, except the present one, have been unsuccessful. The ledges are small, and as soon as the water level is reached, carry the gold largely with the sulphurets. Lack of knowledge of the proper methods of treatment and the imperfect facilities available have led to the frequent abandonment of the district and its condemnation. Curiously enough it has been on the theory that the pay ore did not go down. The actual fact is that the miners did not go down, but limited their operations to scratching close to the surface. A more intelligent knowledge of the condition of the gold in the ores of this district is leading to its extensive exploitation. At no previous time have there been as many mining operations under way and with more favorable prospect of success. The country rock formation, inclosing the best developments made, is serpentine, containing considerable calcite, but the adjacent slates and granites are full of ledges carrying low-grade gold ores.

High up on the slope of Old Baldy, 2 miles by wagon road from the junction of the Eliza Fork with the North Fork of Humbug Creek, is the North Star Quartz Mine, more commonly known as Boyle's Mine. It is owned by Messrs. Gonzales, Osborn & Boyle, the latter being in immediate charge. It embraces two locations on one ledge and a third on another ledge. The mining is all being done on the North Star and Pocket, the adjoining locations. The country rock is a serpentine. On the ledge 800 feet of continuous ore shoot has been mined, and on the surface 900 feet additional has been stripped. The ledge is faulted and broken to a considerable extent. It is opened through three main crosscut tunnels. These are, respectively, 256, 208, and 60 feet long. From the first of these the ledge is drifted on 700 feet southerly and 340 feet northerly, 450 feet of this being in pay ore. The thickness of the ledge on the pay shoot varies from 3 or 4 inches to 6 feet, the average being 12 inches. The extreme depth on the ledge yet reached is 150 feet and is above water-level. Most of the ground being mined out above the present tunnel, a fourth crosscut tunnel is projected to cut the ledge 180 feet lower. The crosscut tunnels are very cheaply constructed, costing only $2 50 per foot and requiring no timbering. In the stopes only stulls and headboards are used, the ground standing well. From the dumps at the tunnels the ore is hauled to the mill by wagon, but from No. 4 tunnel will be trammed direct.

The mill plant is complete and satisfactory in its workings. It consists of a four-stamp battery, stamps weighing 650 pounds, and a 3-foot Huntington mill. The power is steam. The stamp battery screens are

Nos. 5 and 6 slot. From the battery plates the pulp feeds to the Huntington, provided with Nos. 10 and 12 slot screens. Ten tons of ore is milled every twenty-four hours. The consumption of wood is one and one half cords. Of the gold, 85 per cent is saved in the stamp battery and 15 per cent in the Huntington. What escapes the Huntington is not considered worth saving, the sulphurets carrying little gold after going through both mills. All the ore milled has averaged $20 a ton. Some of it has been very rich, milling $100 a ton. About twenty men are employed ordinarily—one foreman, two mill men and engineers, twelve miners, and three outside men.

Over the mountain a few hundred yards distant is the Spencer Mine. It is in the same formation as the North Star, and like it has well-defined walls. It is a very flat vein, pitching into the mountain at an angle of 35° to the southeast. The length of the ore shoot mined is 270 feet; the thickness of the vein being 1 or 2 inches to 3 feet, and averaging 2 feet. The occurrence of the pay quartz is in kidney-shaped masses, as they are termed by the miners. The ore taken out of the shoot is remarkably high grade, though there is very little specimen rock. The sulphurets consist of pyrite, blende, and galena, with traces of copper and arsenic. The mine is opened by an incline shaft on the shoot, a steam hoist being used. The incline is down 300 feet. Pumping is done with a No. 5 Blake pump, steam being piped down the shaft to it. All of the ore is sacked at the mine and hauled to a small steam custom mill, located at the Forks of Humbug, 6 miles distant. But little timbering is required in the mine, only stulls and caps being used. The ore contains 3 per cent of sulphurets, which, cleaned, assay $360 per ton. The mill returns of the ore range from $20 to $300 per ton, the average being very high. Employed at the mine is a force of twenty men—two foremen, two engineers, two millmen, eight miners, two carmen, two teamsters, and two woodcutters. The ore taken out to the miner is 1,600 pounds.

A mile up the North Fork from the junction with the Eliza Fork is the Mountain Belle Quartz Mine, owned by Messrs. Cartwright & Phillips. The country rock is serpentine, but the walls of the ledge, unlike the two already described mines, are other rocks. The hanging wall, about 30 feet thick, is a calcareous slate, and the foot wall an impure limestone. Both are quite hard and well defined. The ledge, which is stronger than either of the other two noted, crosses the cañon so that it can be opened to a considerable extent by an adit tunnel running on it. The ledge dips about 45° to the southeast and toward the face of the hill. It is opened by several crosscut tunnels, respectively, 75, 100, and 280 feet long. The last gives 315 feet depth on the ledge from the croppings, and is over 150 feet below the water-level. The ore shoot drifted on in all three of the tunnels is 140 feet long, and a second shoot has been found in the adit tunnel on the ledge, its length being about 55 feet. The thickness of the pay quartz varies from 12 to 24 inches. The work so far done is only to open up the mine, the only ore milled being that taken from the drifts on the ledge; the two crushings made, aggregating 143 tons, paid $43 50 per ton. The ore on the lower level, 315 feet from the surface, is the highest grade of any yet found, and carries 4 per cent of sulphurets assaying $50 per ton. An assay of the ledge matter in the lower level, not the quartz, gave $6 in free gold and 4 per cent of sulphurets assaying $50 per ton. The gold in the quartz is fine, there being little or no specimen rock.

The three mines above described are the most developed in the district, but there are numerous promising prospects that are likely to make equally fine developments. The Nelson Quartz Mine, owned by C. J. Nelson, is situated east of the Spencer Mine. It is small but very rich, the ore from it milling several hundred dollars a ton. Hegler Bros. have a location 2 miles below the Mountain Belle. It is opened by a crosscut tunnel 150 feet long, and a drift 600 feet on the ledge. The ledge is low grade, but its thickness is from 2 to 6 feet. The ore mills only $5 in free gold, but is claimed to carry 5 per cent of sulphurets assaying $200 per ton. The Jackson Mine, owned by E. B. Jackson, is being prospected, and shows some rich ore. In addition to the preceding, there are numerous others as yet only locations. It is, however, safe to say that Humbug District is showing every indication of becoming a large gold producer.

DEADWOOD.

Only one quartz mine is being worked in this district, the Schroeder & Warner, but in it are included all the quartz veins that have been found there. It has been worked continuously for six years, and is a paying property. The formation, course of veins, dip, and mineral characteristics are those of the quartz veins of the Humbug District.

HUNGRY CREEK.

This is a new quartz mining district, situated about 10 miles west of Cole's Station, on the California and Oregon Railroad. The ledges so far are simply prospected, there being about a dozen locations made. The course of the ledges is northeast and southwest. On the Fairy Queen location there is a tunnel now in 250 feet. On the Sterling there are both shafts and a tunnel. A mill test on a 400-pound sample of the ore from this mine milled at the rate of $6 50 a ton in free gold and $5 in the sulphurets, or $11 50 a ton. On the Spencer location a shaft is down 60 feet on a ledge 14 inches thick. A two-stamp mill has just been put up in the district.

YREKA.

In early mining days the scene of the greatest activity in placer mining, this district is, at the present time, making no new developments. The placers are not being mined, there being no available water. A plan is under contemplation to utilize the fall of the water in Shasta River to pump a large stream to an elevation sufficient to give a hydraulic head, and to operate elevators. A blue gravel prospect has been struck in Greenhorn Creek, but at the time of my visit the shaft was full of water.

In 1891 an attempt was made to prospect for the blue gravel channel under the sandstone east of the town. A shaft was put down 110 feet, the last 92 feet of it being in a hard, cemented, blue gravel. The attempt was abandoned, being insufficiently backed with capital, though the prospect obtained was encouraging.

SCOTT BAR.

This is a placer and quartz mining district, situated on Scott River, just above its junction with the Klamath. It was the first locality to be mined in Siskiyou County, and has been a remarkably rich district, although it includes a very small area. The placers of the river bed of Scott River and some considerable areas of bench gravel similar in appearance and probable formation to those of the Klamath, though they contain gold, resemble that found in the Stockton Drift Mine in Quartz Valley and that found in the South Fork at Callahan's Ranch. The gold is nugget gold, smooth and water-worn, and is found on the bedrock.

The placer claims, with two exceptions, are small, and operated on a very limited scale. Reynolds & Jacobs are hydraulicking in a bench 2 miles south of Scott Bar. They have a large claim that pays well, but lack of water limits their operations to work with a small rig in winter. McGuffey Bros. have also a considerable area of rich hydraulic ground, but have no available water supply. The Graveyard Hydraulic Mine, a small claim situated right in the town of Scott Bar, was running at the time of my visit. It employs three men and pays moderately. Several small drift claims are being run and employ one or two men each. They are wages claims and cut no figure in the gold product. In the river bed two white and two Chinese companies are working. The latter are the larger operations, each of them employing ten men. The annual production of all the mines in the district, excluding the Scott River Hydraulic Mine and the Quartz Hill Hydraulic Mine, is $40,000.

The Scott River Mining and Canal Company (incorporated), owning a large area of the bench gravels, after hydraulicking for some years with moderate success, have temporarily suspended it to prospect the ground by drifting. The water supply now on the mine is brought in 12 miles of ditch and flume from Tompkins Creek. It lasts from sixty to ninety days, though the actual running time that can be had is much less, being hardly one third. The ditch head of 1,600 inches has to be reservoired to give a full pipe head to the No. 7 giant running under 400 feet pressure. The necessary surveys have been made and some ditch constructed to increase the quantity and to give a longer water season. Nine miles of ditch, estimated to cost $30,000, will bring in the water of Cañon and Kelsey Creeks, from which an unfailing ditch head can be had during the entire year. The construction of this ditch will be of great value to all the mines of Scott Bar District other than the particular mining ground inducing its construction. It will be the only water supply high enough to give a hydraulic pressure for that class of mining and will be available for mining several hundred acres of hydraulic ground south of Scott Bar.

Across the river from Scott Bar is the Quartz Hill Hydraulic and Quartz Mine. This property has been lying unworked for the last two years, pending litigation in which it was involved. There are several large quartz ledges on the property, one of them being mined. The surface has been very rich hydraulic ground. There is a fine ten-stamp water-power mill on the mine, and a large hydraulic rig. The water supply is taken out of Scott River, and brought down by a ditch on the west side, from which it is piped across to the mine. There is some probability that the mine will be reopened and operated during the

season of 1892–93. When running it is a large producer and employs a large number of men.

COTTONWOOD.

This district is exclusively placer in its mining industry. It is located on the north side of the Klamath River, 18 miles northeast of Yreka. Originally noted for its rich, shallow diggings in Cottonwood Creek and the ravines tributary to it from the west, its special interest now is in the development of the old blue lead channel, which is here exposed by erosion of the capping sandstones, and where cut through by the Klamath River. Aside from some unimportant placer mining with rockers on the gravels of Cottonwood Creek, the only mining is on the blue lead, where it is cut by the Klamath River, 2 miles south of the town of Henley, formerly Cottonwood. This mining is being done by what is known as the Blue Gravel Mining Company (incorporated). Their locations include a tract of land extending 2 miles north of the river, and covering the blue lead channel, which can be distinctly traced by its exposed rims from 1,000 to 1,200 feet apart. The sandstone capping is full of fossils and pebbles in places, but where clear is of excellent quality for industrial use. It is extensively used in the construction of the culverts of the California and Oregon Railroad, which runs through the valley of Cottonwood Creek, 2 miles east of the deposit. Both the channel and the capping are considerably displaced, and dip on an angle of about 10° to the east. Though the compact cemented blue gravel had been discovered and mined to some extent in one of the ravines tributary to the Cottonwood, it was not until 1887 that the outlet of the channel was discovered and located on the Klamath River. The outlet was first drifted on with prospect tunnels, and then rigged up as a hydraulic mine. Away from the action of the atmosphere the gravel is blue and strongly cemented and compacted, requiring powder to break it up for piping. The gold is coarse, large nuggets being frequently found. Most of it lies on or close to the bedrock. So compact and cemented is the gravel that I am of the opinion that certainly one third of its gold is carried through the sluices and into the dump. Despite this probable loss the mine has been very productive for the work done. In three seasons only a small pit on the west rim has been washed out, and the ground is hardly opened. The average pay per square foot of cleaned bedrock off the outer rim is $1. Gravel from a drift on the bedrock in the lower portion of the pit washed up at the rate of $6 a cubic yard, and the average of all the ground hydraulicked has been 24 cents a cubic yard. In the year 1892, sixty days' run with 700 inches of water used from reservoirs that only gave two hours run at a time, returned $12,000, being at the rate of $200 a day, and 29 cents an inch for the water. The present hydraulic bank is 70 feet high, and contains considerable pipe clay hardened almost to the consistency of stone, and filled with angular rock fragments. For bank blasting Judson powder is used, and for making the powder drifts 50 per cent gelatine dynamite. In the pit a small quartz ledge carrying gold has been exposed. It is intended to prospect it by a shaft.

On the opposite bank of the Klamath River a prospect tunnel has been run to find the continuation of the blue lead southward. Blue gravel has been found, but not on the bedrock or in the channel. Operations were suspended at the time of my visit.

Adjoining the Blue Gravel on the north is the Black Jack Drift Mine. It is being prospected by an incline shaft now down 180 feet, but not on bedrock. Some of the gravel coming out of the excavation of the incline was milled and yielded at the rate of $3 a ton. Another lot milled $6 a ton. The developments already made on this blue lead channel are so favorable as to warrant extended prospecting and mining on it at other points. For a number of miles of its course it is very advantageously located for opening and working.

Reference has been made to the existence of coal seams stratified with the sandstones. At Willow Creek, 4 miles from Ager, a 3-foot vein has been prospected by an incline for 340 feet, with 100 feet of crosscut, at a depth of 170 feet. A borehole sunk 700 feet east of the outcrop cut the seam at a depth of 134 feet. The seam is found uniform in thickness and of improving quality with increased depth. The prospect is owned by the Siskiyou Coal Company (incorporated), of Hornbrook, Siskiyou County. Nothing is being done with it at the present time.

MINERAL SPRINGS IN SISKIYOU COUNTY.

By W. L. Watts, Assistant in the Field.

THE SHASTA SPRINGS.

These springs are owned by the Mount Shasta Mineral Springs Company, organized in Sacramento in 1889, their purpose being to develop and promote the sale of the Shasta and other mineral waters on the property owned by them in Siskiyou County, and to manufacture carbonated beverages from the waters of their springs.

On the Shasta Springs property three principal springs have been improved and utilized, viz.: the Shasta, the Glacier, and the Keystone springs. The Shasta Spring was first brought to notice in 1887 by the construction corps of the Oregon and California Railroad, and it is situated 4 miles from the town of Dunsmuir, on the east bank of the Sacramento River, which at this point flows through a deep cañon across the property of the above mentioned company.

About the time of the completion of the railroad, the Shasta Spring was improved in a crude way by the workmen, and became an exceedingly popular resort. The year following, the waters of the spring were piped for about a quarter of a mile to Mossbrae Falls, where a small pavilion was erected, forming an attractive stopping place for all trains. The attention of several capitalists was called to the remarkable medicinal qualities of the spring, and the present company was organized.

In May, 1890, the work of improvement and development was actively begun. An analysis of the water was made by Prof. W. S. Haines, of the Rush Medical College, and the bottling establishment was erected. The plan of piping the water to Mossbrae Falls was discontinued, for the water was found to lose carbonic acid gas in transit, and steps were taken to thoroughly develop the springs. The ground immediately around the springs was cleared, and the surface removed to bedrock, which proved to be a tufa, exhibiting microscopic lines of sedimentation; this was thoroughly cleansed and the main fissure from which the

Shasta Spring issued was exposed. The tufa is overlaid by doleritic lava.

Upon exposure the main fissure was found to be from 4 to 8 inches in width, running approximately north and south, the pitch of the formation being toward the west at an angle of about 60°. From the fissure flowed the Shasta Spring, the water of which appeared to be in a state of violent ebullition from the gas that was being evolved.

Numerous small springs were discovered in the exposed surface of the bedrock. All of these were carefully closed by the following method: The necks of bottles were broken off and placed over the points of gas and water leakage, and surrounded with cement, so that the gas and water could escape through the bottle necks and allow the cement to harden. After the cement had set the mouths of the bottle necks were corked and a heavy layer of cement spread over them. The object of this was to force everything into the main fissure.

The Shasta water, no doubt owing to the amount of free carbonic acid gas that it contains, was found readily to dissolve the fresh cement, but it had no effect on it after it had set. The main fissure of the Shasta Spring was arched over, with the exception of the principal vent, over which a concrete reservoir was built. This reservoir is divided into two compartments, the front being an open drinking basin for the use of the public, and the rear a hermetically sealed reservoir, the interior dimensions of which are about 3 feet in diameter and 6 feet in height; the top is closed by a heavy concrete cover, held in place by large iron bolts and nuts; the outer edges of the planes of contact are closed with cement. Thus the rear reservoir forms a chamber wherein a plentiful supply of gas and water is accumulated and stored in its natural condition. From this chamber a pipe leads directly to a small structure, in which the bottling machinery has been erected and the process of bottling the natural water is carried on. The only metal allowed to come in contact with the water is tin, which is found to best withstand the action of the water and gas.

The slope of the pipe running from the storage reservoir to the bottling works is the reverse of that usually employed for carrying water, it being laid on an ascending grade, the gas pressure being sufficient to force the water through the pipe.

The method of holding the gas and water in the reservoir is as follows: A tin pipe, 2 inches in diameter, is bent upon itself in a circle until the ends protrude about 1 foot in opposite directions; one end is connected with the bottom of the public fountain and the other with the reservoir. The gas and the water are forced through the pipe until the basin of the public fountain is partly filled. As soon as the weight of the water in this basin and the weight of the atmosphere pressing on its surface are sufficient to balance the pressure from the spring, the water and gas accumulate in the reservoir supplying the bottling works; but when the gas pressure in this reservoir increases sufficiently to overcome the column of water in the public basin and the weight of the atmosphere, a free flow ofgas and water forces its way into the public basin with geyser-like discharge. This occurs about once in twenty minutes. In the construction of this apparatus every precaution was taken against contamination, so that when the water escapes into the public drinking fountain it is for the first time exposed to light and air.

In July, 1891, the capacity of these works was one carload of bottled

water a day, but the manager stated that the company contemplated increasing their works in the near future.

THE GLACIER SPRING.

This spring, which is situated about 300 feet above the Shasta Spring, has also been improved by the Mount Shasta Mineral Springs Company. Upon the removal of the surface debris, the outlet of the Glacier Spring was exposed; this was found to be a rift in the bedrock 15 feet wide by 6 feet in depth. This rift was filled with lava, pebbles, and bowlders, varying from the size of a hen's egg to that of stones a foot or more in diameter. The water flowed with great velocity between the interstices of the bowlders. The rift appeared to be water-worn and the bedrock is of a similar character to that observed at the Shasta Spring. The bedrock was capped with doleritic lava, which in turn was covered with loam. The direction of the rift was north and south. In improving the Glacier Spring, the mouth of the rift was cleared and an excavation made to bedrock; during this operation, a timber bulk-head was built with lagging to prevent dislodgment of the bowlders by the force of the water. After reaching the bedrock, at a depth of about 12 feet, a concrete basin was built; the foundation was laid in the bedrock, and wingdams constructed at each side of the stream to concentrate the flow of the water.

THE KEYSTONE SPRING.

This spring is similar to the Glacier Spring, but smaller; it furnishes water to the plateau above the springs, on which plateau it is the intention of the Mount Shasta Mineral Springs Company to build a hotel. There are several other mineral springs on the company's property which appear to possess valuable mineral qualities.

GEOLOGICAL FEATURES OF THE VICINITY.

Following down the railroad track to the bridge, the writer observed a mineral spring on the western side of the river, close to the masonry of the bridge; its waters had the taste of brine, and they were effervescing with carbonic acid gas.

On the western side of the river, above the bridge, the formation is anamesite, and similar rock was observed on the eastern side of the river, both above and below the railroad station, it being occasionally much altered and whitened by water which streams down the embankment in many places. At one point on the western side of the river a small quantity of aragonite has been taken out, it having, no doubt, been formed by a mineral spring noticeable in the quarry. For some distance up the river, on its western bank, the formation is anamesite, together with some conglomerate. All along the western margin of the river numerous mineral springs seep and trickle from the rock, staining it in places with oxide of iron; some of these springs give off sulphuretted hydrogen.

South from the bridge the railroad cutting shows doleritic lava, while opposite the Upper Soda Springs a bluff of syenite rises to the height of several hundred feet above the track; this syenite is remarkable for the

light-colored hornblende that it contains. Farther south, toward Dunsmuir, basaltic lava is noticeable, presenting a distinctly columnar structure.

UPPER SODA SPRINGS.

These springs, which are the property of John Masson, are situated on the eastern side of the Sacramento River, near Dunsmuir, on the California and Oregon Railroad, and about 2 miles south from the Shasta Springs. The Upper Soda Springs have, no doubt, a similar origin to their neighbors; they rise through the lava which has flowed from Mount Shasta and other volcanic openings to the eastward.

A specimen of lava taken from a cave on this property, where one of the principal springs occurs, proved to be a dolerite, containing numerous garnets. The water of these springs decomposes the contiguous lava, and fills its vesicles with a white clayey material; finally the feldspathic constituents of the rock are completely kaolinized, and it passes into a clay. The various gradations of this change are very clearly exemplified in the cave above mentioned; in the cave a small amount of sulphuretted hydrogen is perceptible.

The water of the Upper Soda Springs is charged with carbonic acid gas; it is especially recommended for urinary and stomachic complaints. At these springs there is a hotel capable of accommodating about fifty guests.

Between the Upper Soda and the Shasta Springs are the Mossbrae Falls, formed by a small stream falling about 50 feet over a cliff of lava. Immediately beneath the falls mineral water oozes from the rock in several places.

THE SCOTT SPRINGS.

These springs are situated on the property of J. J. Scott & Co., in Sec. 7, T. 39 N., R. 3 W.; they are about three quarters of a mile southeast from the Shasta Springs. At this point there are four springs, which break forth close together, and when visited by the writer, in 1891, they emptied into the same pool. There was a considerable evolution of gas from the pool, but it is said to come only from one spring.

The pool into which the springs empty was too much choked with mud, and the surrounding country too densely covered with forest growth, for the writer to be able to examine the formation in the immediate vicinity. A shed was at one time built over this spring, but it had fallen down.

SONOMA COUNTY.

By W. L. WATTS, Assistant in the Field.

The only mining in progress in Sonoma County during 1891–92 which came under the notice of the California State Mining Bureau, was at the Great Eastern Quicksilver Mine and at Pine Flat, as hereinafter described, together with some work which was carried on upon a ledge said to show gold, silver, and copper, near Cazadero.

The following notes on the water supply and the superficial strata of the valley lands have been gathered from various well-borers and parties who have taken sufficient interest in the subject to make observations at the time wells were bored on their property.

Although inflammable gas has been observed at several places in Sonoma County, yet so far as could be learned, Tubbs Island, near the mouth of Petaluma Creek, appears to be the only place where it is used.

WATER.

Commencing on the northern shore of San Pablo Bay, at the mouth of Petaluma Creek, inquiry shows that most of the wells flow at a depth of something less than 300 feet; in that vicinity the following formation has been observed:

Soft marsh mud	50 feet.
Blue clay interstratified with sand	200 feet.
Gravel, with flowing water.	

Many of these wells yield inflammable gas, but they are troubled with quicksand, which necessitates a periodical cleaning out. Between Lakeville and Petaluma the surface water is struck at a depth of about 12 feet, and wells for domestic use seldom exceed a depth of 20 feet, the water rising to within 8 feet of the surface.

The town of Petaluma is supplied by the Sonoma Water Company, who obtain water from Lynch, Adobe, and Copeland Creeks. These creeks take their rise from springs in Sonoma Mountain, distant about 6 to 9 miles eastward from Petaluma. They supply about 150,000 gallons in twenty-four hours during the dry season, and during the winter one creek is found to be enough for all requirements. The average amount of water consumed in Petaluma is placed by the water company at 140,000 gallons in twenty-four hours. Besides this supply, the company also owns a storage reservoir of 40,000,000 gallons capacity, situated on the Sonoma Mountain about 6 miles east of Petaluma. This reservoir is filled during the winter months by one branch of the Adobe Creek. The catchment basin yielding the water supply is estimated at about 20 square miles. Inside the city limits there is a distributing reservoir of 2,500,000 gallons capacity, the walls and floor of which are of cement. The elevation of this reservoir affords a head of 175 feet.

The citizens of Petaluma also obtain water from numerous private wells, and a good supply of surface water is obtained from dug wells in most parts of Petaluma at a depth of from 25 to 30 feet.

The formations observed by the local well-borers in boring in and around Petaluma is as follows:

At the foundry, near the center of Petaluma:

Earth and sand	35 feet.
Black mud	55 feet.
Gravel, with what appeared to be bark and rotten leaves	10 feet.
Black mud.	

The water rose to within a distance of from 10 to 15 feet of the surface.

In the southeastern outskirts of Petaluma, on the western side of the creek, black mud has been observed to a depth of about 200 feet. This is frequently interstratified with sand, and occasionally small bowlders are encountered. Hard surface water is obtained at a depth of from 15 to 20 feet, but deeper borings yield a softer water, which rises to within 15 feet of the surface.

A well was bored near the center of the town, to a depth of 150 feet, at which depth the water flowed over the casing. This well was about 50 feet distant from Petaluma Creek.

At the old Central Mill a strong "vein of water" was struck at a depth of 75 feet. Two steam pumps, each drawing from 15,000 to 20,000 gallons in twenty-four hours, lowered the water to a depth of only 14 feet from the surface. The western limit of the line of black mud extends, apparently, about 700 to 800 feet west of the creek, probably trending farther to the west as it approaches the northern portion of the town. Earthquakes are felt the most severely in the portion of the town underlaid by this black mud. West of the line of black mud a "tough rock," which yields a supply of water, slopes to the southeast at an angle of about 45°. The "tough rock" is no doubt a tufa, which crops out in the western limits of the town.

About 1,500 feet west of the foundry a well was dug to a depth of 23 feet and bored to a depth of 85 feet, when the water rose to within 5 feet of the surface. This well, which was sunk to supply a laundry, yields about 6,000 gallons of water in twenty-four hours, and could probably furnish much more. The top of this well is about 50 feet above the level of Petaluma Creek.

About 300 feet to the northwest of the laundry well a well was bored to a depth of 363 feet. The first 350 feet was in rock, and at that depth a decomposed quartz was struck. At 363 feet the quartz became solid, and the drill made but little impression upon it. The quartz was assayed, and showed $9 and some cents in silver and $1 in gold to the ton. Subsequent assays of small fragments of the borings showed between $5 and $6 to the ton.

On the eastern side of Petaluma Creek, about 250 yards from the railroad track, a well was sunk on Washington Street to a depth of 320 feet in black mud, and a small flow of water was obtained. Flowing water was struck at a depth of about 200 feet on the Putnam ranch, about 1 mile east from Petaluma.

In other wells of equal depth in that neighborhood the water rises to within a few feet of the surface, and although they do not flow they yield an inexhaustible supply by pumping. Three miles east from

Petaluma Creek, near the Sonoma Mountain, black mud has been penetrated to a depth of 250 feet.

In the western outskirts of Petaluma, where the rock lies near the surface, the water is more uncertain, but there are several good springs, from which in the early days of California a supply of water was obtained.

About 2½ miles to the north of Petaluma the formation is sand, interstratified with yellow clay, and the first water is struck at a depth of from 40 to 50 feet, but it is very hard; in this vicinity bored wells, 200 feet in depth, yield a good supply of water, which rises to within 15 or 20 feet of the surface. In boring on the Cotate ranch many cobblestones have been met with.

Near Two Rocks the following formation was observed:

Fine sand and quicksand	50 feet.
Yellow clay	30 feet.
"Swelling clay," mixed with sand and gravel	98 feet.

At this depth a coarse gravel was struck, which yielded a good supply of water. The water rose to within 16 feet of the surface, although the well was situated on the hillside, some 60 feet above the valley. In many wells in this vicinity good water has been obtained after penetrating 90 feet of sand.

WATER SUPPLY AT SANTA ROSA.

Santa Rosa is supplied with water by the Santa Rosa Waterworks Company, which was incorporated in 1873. This company obtain water from the head of Santa Rosa Creek, which takes its rise in the hills to the east and northeast of Santa Rosa.

The water is piped about 1 mile to a reservoir, situated some 2 miles eastward from the city. This reservoir covers about 26 acres, and averages probably 30 feet in depth. The water is piped from the reservoir to the town. There are two mains, one being an 11-inch pipe and the other a 9-inch. The fall between the reservoir and the town is about 80 feet. As the water is not sold by meter rates the daily consumption was not obtainable.

In a well bored about 10 miles south of Santa Rosa, near Goodwin Station, the following formation was penetrated:

Hard cement	20 feet.
Sand, with water	2 feet.
Hard bluish stratum	20 feet.
Blue clay	10 feet.
Hard, blue, cement-like sand rock	20 feet.
Blue unctuous clay	10 feet.
Clay and sand	10 feet.

In this vicinity the surface water is usually struck at a depth of about 20 feet, but wells are usually bored about 20 feet deeper.

At Stony Point the wells are deep and the water supply uncertain, the rock being near the surface.

Directly east from Sebastopol the wells are from 25 to 50 feet in depth, strata of adobe soil, clay, and gravel being penetrated; the water rises to within 10 or 12 feet of the surface. Between Sebastopol and Santa Rosa the formation is usually sandy to a depth of 100 feet; good water is obtained at a depth of from 40 to 100 feet, but quicksand is troublesome and a "false bottom" of gravel is frequently resorted to.

At the Vine Hill ranch, on the low sandy hills on the western side of the valley, about 9 miles northwest from Santa Rosa, sand was penetrated for 94 feet, beneath which was a stratum of shell marl, showing numerous Pliocene shells; beneath the shell marl was sand with water.

At the school house, a few hundred yards east from the Tucker well, sand was penetrated for 102 feet before water was reached. The water did not rise in the pipe and a deep pump was used.

Around Fulton the wells are usually dug, and they seldom exceed a depth of 30 feet. In the central portions of the valley the water stands at a depth of from 10 to 20 feet from the surface, and along the edge of the hills the houses are generally supplied by springs.

In a well bored at the Talmage ranch, in the Russian River district, the formation was found to be as follows:

Sandy loam	5 feet.
Sand "rock"	4 feet.
Sandy clay	50 feet.

Gravel with water. A deep pump was used.

East and southeast from Santa Rosa ancient watercourses appear to lead up into the hills. Wells penetrate a formation that varies greatly, being alternations of clay, gravel, and bowlders. The depth at which a supply of water can be obtained is from 20 to 40 feet in the edge of the city limits, and from 60 to 80 feet as the hills are reached.

At a distance of 1½ miles from Santa Rosa, in the Hearn School District, a redwood stump was bored through in a bed of gravel at a depth of 23 feet.

Several years ago Mr. J. M. Walker bored a well about 4 miles south of Santa Rosa, and the following formation was penetrated:

Gravel mixed with sand	5 feet.
Gravel	8 feet.
Clay	47 feet.
Gravel	10 feet.
Gravel mixed with clay	82 feet.
Quicksand	45 feet.
Blue clay	105 feet.
Gravel	18 feet.
Gravel and sand	85 feet.
Larger gravel	35 feet.
Gravel	40 feet.
Gravel mixed with sand	200 feet.
Cemented gravel	90 feet.
Sand	45 feet.
Total depth	815 feet.

At a depth of 168 feet a log of wood about 2 feet in thickness was bored through. From 152 to 197 feet the auger appeared to pass through a stream of water, as tule roots, twigs, and leaves were brought to the surface. At a depth of 230 feet a small flow of water was struck; this was cased off, and the well sunk to 530 feet, when another small flow was obtained. This well flows at intervals, and when flowing yields about half an inch of water, and the water has never been known to sink lower than 18 inches below the surface. No gas was observed in this well.

In 1888 Dr. Lawrence sunk an artesian well to the depth of 180 feet, at his residence, about a quarter of a mile north from the plaza, in the town of Sonoma. From observations made by the doctor, as to the springs and seepage of water from beneath the lava at the base of the

mountains to the north of the town, he came to the conclusion that flowing water could be obtained by penetrating the strata underlying the lava. He first ran a tunnel into the mountain about 200 feet through the basaltic lava capping until he struck the tufa underlying it. Then, commencing higher up on the slope of the mountain, he bored about 50 feet through the lava until he penetrated the roof of the tunnel. The boring was continued through the floor of the tunnel and a grayish tufa, which contained much water, was passed through for about 55 feet. A soft, white, pulverulent rock was then encountered; this stratum was about 40 feet in thickness and in places stained with oxide of iron; beneath the white stratum gravel was penetrated for about 15 feet, with flowing water. This well yields about 300,000 gallons of water in twenty-four hours. The temperature of the water is 42° Fahr., and is about the same as that of a flowing spring about half a mile distant on the ranch of the late General Vallejo.

Since the experimental boring by Dr. Lawrence, flowing wells have been obtained in several places in the town of Sonoma and its vicinity, usually at a depth of something less than 200 feet. On the property of J. A. Popper, a boring was made to the depth of 170 feet, all the way in rock. The character of the formation was found to be as follows: Soft red rock, hard brown rock, white rock, hard brown rock; beneath the last stratum flowing water was obtained.

On the property of C. Aguillon, also in the town of Sonoma, the following strata were penetrated: Cement rock, blue clay, red rock, white rock, hard dark-colored rock; beneath this flowing water was obtained.

Most of the flowing wells in the town of Sonoma will flow from pipes at a height of about 25 feet above the level of the plaza. In other wells in Sonoma similar character of formation has been observed, but in some instances the wells are less than 150 feet deep.

South from the town of Sonoma surface water of fair quality can be obtained at a depth of from 10 to 20 feet, and strata of lava are encountered; lava is also penetrated by borings near the hills to the north of the town.

In boring a well at El Verano the following formation was noted:

Gravel	60 feet.
Blue clay	240 feet.
Sand and hard cement	14 feet.
Blue clay intercalated with sandy strata	230 feet.

This well does not flow.

At Embarcadero, on the McMackin ranch, the formation is as follows:

Soil	10 feet.
Alternate strata of gravel, clay, and sand	380 feet.

At this depth "something like crude oil" flowed with the water.

Cement	15 feet.

The water flowed from a pipe 15 feet above the surface.

On the Atterburg ranch, in Los Guilicos Valley, a well showed a dark clay loam for 60 feet, beneath which a hard cement was penetrated for 40 feet; the water rose to within 7 or 8 feet of the surface.

At the S. Hutchinson ranch a cement gravel was penetrated for 170 feet, yielding a fair supply of water; but although the boring was continued to a depth of 212 feet, no increase was obtained.

In the Huichica Hills, on the Venoni ranch, facing the bay, blue clay was bored through to a depth of 260 feet, and flowing water was

struck in the sand; the water rose in the pipe 12 feet above the surface. The top of this well is about 150 feet above the bay.

Three wells were bored on the marsh near the Donahue drawbridge. A blue clay was penetrated for 140 feet, beneath which was a peaty-looking stratum about 5 feet in thickness, "with some oil" and flowing water. This was cased off, and boring continued to a depth of 242 feet. through blue clay interstratified with sand; at this depth a good stream of flowing water was obtained, which rose 3 feet above the surface of the ground. About 1½ miles north of this well a blue clay was penetrated for 190 feet, beneath which a hard white rock was encountered, about 1 foot in thickness; on penetrating the rock flowing water was struck. which rose in a pipe 7 feet above the surface.

On the Martinelli ranch, about 2 miles north of the drawbridge, an unctuous, clayey cement was penetrated for about 250 feet, and three streams of flowing water were struck between a depth of 150 and 250 feet. These flowed about 2 miner's inches, and rose in a pipe 6 feet above the surface of the ground.

Since the writer's visit to Sonoma a strong flow of water was struck on the Jones tract, which borders on Sonoma Creek; the well is said to yield inflammable gas.

SPRINGS AND WELLS YIELDING INFLAMMABLE GAS.

Inflammable gas bubbles up from the bed of Sonoma Creek on the Captain Boyes ranch, about 2 miles north of Sonoma. About 100 feet from the creek is a thermal spring, already mentioned in the reports of the State Mining Bureau. The temperature of this spring has been estimated at 110° Fahr., and the water is kept in a state of ebullition by the inflammable gas which arises from it. Captain Boyes states that he has estimated the amount of gas yielded by the spring at 9,000 feet in twenty-four hours. This spring, like others in the Sonoma Valley, was known from the earliest settlement of the country as possessing medicinal qualties, and was resorted to for bathing by the Indians and Spaniards, by whom the spring was known as the Agua Rica.

A few yards to the east of the spring, and 120 feet from the creek, a boring was made by Captain Boyes to a depth of 37 feet:

Adobe	5 feet.
A vein of cold water.	
Adobe	5 feet.
A vein of tepid water.	
Adobe	15 feet.
Gravel	12 feet.

At this depth the well yielded inflammable gas and water of about the same temperature as the spring already mentioned. The flow of water from this spring has been estimated at a quarter of a million gallons in twenty-four hours. A 6-inch hose siphoned water into the creek continuously for twenty-four hours without lowering the water in the spring.

In the tule lands in the salt marsh toward the mouth of Sonoma and Petaluma Creeks, inflammable gas has been observed in many wells at a depth of 150 feet, the formation being as already noted under the head of "Water"; also on the Poppe ranch, about 3 miles southwest from Embarcadero. Natural gas is used both for heating and lighting

on Tubbs Island, near the mouth of Petaluma Creek. At the junction of the Bennet and Rincon Valleys, inflammable gas has been observed arising from a swamp caused by the overflow of warm springs.

COAL.

A visit was made to "Coal Croppings" on the Long ranch on the eastern face of the hills forming the western side of Sonoma Valley, distant about 2 miles west of Agua Caliente railroad station.

Two seams of rock, much impregnated with carbonaceous matter, are here exposed, one of which passes into a light variety of lignite. The formation stands at a great angle. The carbonaceous portion is interstratified with a light-colored shale of but little specific gravity. The head wall is a light-colored shale showing fresh-water diatoms.

The foot wall of the upper carbonaceous stratum, which is also the head wall of a lower carbonaceous stratum, is a tufa some 6 feet in thickness. Beneath the tufa is a stratum of a light variety of lignite, somewhat resembling the Ione coal of Amador County. The foot wall is a light-colored shale, resembling the head wall of the upper carbonaceous stratum. The barometer at this point showed 265 feet above Agua Caliente railroad station.

A specimen of lignite from the Long ranch was analyzed by Dr. W. D. Johnston, Chemist of the Bureau, and it showed:

Moisture	12.75 per cent.
Volatile carbonaceous matter	31.25 per cent.
Fixed carbon	26.75 per cent.
Ash (light yellow)	29.25 per cent.

There is a great similarity between the formation at the Long ranch and that at Mark West. The Mark West Creek has cut deeply into its southern bank a short distance eastward from the old mill, disclosing a formation very similar to that described on the Long ranch.

The carbonaceous strata are more or less impregnated with pulverulent shaly matter; the wall rocks are light both in color and specific gravity, sometimes showing the outlines of plant remains and fresh-water diatoms. The formation dips to the west of north magnetic at an angle of about 40°. The land adjacent to the south side of the creek belongs to the Rector estate, and is now in the market.

A large amount of prospect work was done a few years ago upon the northern bank of Mark West Creek; several tunnels were run and crosscuts made. Much of the lower working has caved in, but the tunnel highest up the hill, with its crosscuts and accessory workings, was still in a good state of preservation in 1891, when visited by the writer. The formation is very similar to that on the opposite side of the creek, but somewhat of a more clayey nature; the lignite is more compact, and appears to pitch in the same direction and at about the same angle. Separating the lignite into two veins, which, together at one point attain a thickness of about 10 feet, is a stratum of tufa similar to that observed at the Long ranch in Sonoma Valley. The stratum of tufa at this point is, however, only about 1 foot in thickness.

The following analyses were made by Dr. W. D. Johnston, Chemist of the Bureau:

	Moisture—Per Cent.	Volatile Carbonaceous Matter—Per Cent.	Fixed Carbon—Per Cent.	Ash—Per Cent.
Specimen of lignite from north side of Mark West Creek	13.75	43.00	20.50	22.75
Specimen of lignite from south side of Mark West Creek	12.00	34.75	17.50	35.75

"Coal prospects" are also said to have been discovered at the Carson, formerly the Sewell ranch, on Mark West Creek, near Guerneville; and also near Geyserville; some work is said to have been done at both places, but time was too short to admit of their being visited by the writer. Some prospect working is also being carried on in the Bennet Valley side of Taylor Mountain.

Coal is said to have been mined at an early day on the ranch now owned by G. W. Call, near Fort Ross, but the workings are now caved, and a dark-colored shale is all that is in sight. Also on the Gualala River, about 8 miles northeast of Stewart's Point, in 1878, some coal is said to have been taken out. The first work was done in the river bed, but it is now timbered over and covered with river wash. The vein is said to have shown a thickness of 22 inches at a depth of about 5 feet. At the same place a shaft was also sunk a few feet from the river bank, but no coal was taken out. All that is in sight is a stratum of shale about 2 feet in thickness cropping out in the river bed; the shale is standing almost vertical, and has a strike of slightly south of east by north of west magnetic.

The adjacent rocks in the creek are somewhat altered shales and sandstones. The disturbed character of the strata and metamorphism which the adjacent rocks have evidently undergone render it improbable that a remunerative body of coal will ever be struck at this point. The rocks on the sides of the cañon in which the work was done are for the most part highly metamorphic. Mica slate and jasper shales are observable in several places.

GOLD AND SILVER.

Some work is being carried on by J. Gray, on Austin Creek, about 3 miles northeast from Cazadero. The ledge is said to show copper, silver, and gold.

About seven years ago gold quartz, which assayed $15 in gold and silver to the ton, is said to have been found on the Lancaster ranch, east of Stewart's Point; some prospect work was done there, but no regular ledge was discovered.

QUICKSILVER.

The Great Eastern Mine.

This mine is still operated by the Great Eastern Quicksilver Mining Company, which was incorporated under the laws of the State of California, April 2, 1875. The principal place of business is Oakland, California. During the last two and a half years, ending June 30, 1892, this mine yielded as follows: In 1890, 1,046 flasks; in 1891, 1,751 flasks; for the six months ending June 30, 1892, 787 flasks.

In the Great Eastern Mine the foot wall is sandstone and the hanging wall is serpentine.

In 1891 a shaft was sunk to the depth of about 40 feet, on croppings to the eastward of the old workings and a new body of ore was discovered, which averaged about 1 per cent of quicksilver. A tunnel was run about 100 feet below these croppings and 800 feet west of the old workings. The new body of ore was struck after tunneling a distance of 100 feet, the foot wall being sandstone. A large amount of "pay ore" was taken from this tunnel. Another tunnel was commenced about 80 feet farther down the hill.

The plant at this mine consists of one 12-ton Maxwell coarse ore furnace and one 16-ton Scott & Huettner fine ore furnace.

Men employed: Two engineers, one blacksmith, seven furnace men, two teamsters, two foremen, twenty-five miners, carmen, and helpers, eight men sorting and breaking ore.

Pine Flat District.

This camp was first brought into notice about fifteen years ago, and claims were taken up on which both cinnabar and metallic quicksilver had been found. Several furnaces were erected along the mineral belt, which extends in a line running southeast by northwest, commencing on the borders of Napa and Lake Counties, and extending through Pine Flat toward Big Sulphur Creek. At that time a camp of several hundred men was established at Pine Flat, and work was continued for about one year. About the same time several other camps were established along this quicksilver belt in Sonoma County, particularly at the Oakland, the Sonoma, and the Pine Mountain Mines.

Quicksilver was then worth about $1 50 a pound. When the great decline in the price of quicksilver took place, work on most of these mines was suspended. The last to succumb was the Oakland, which continued to reduce and take out ore for about four years. It is said that much injudicious work was expended in these locations, and that this was the principal cause of failure.

At the time the writer visited Sonoma County, *i. e.*, August, 1891, a small, but persistent amount of work was being carried on at the Cinnabar King Company's property, which consists of a group of mines in the neighborhood of Pine Mountain; at that point the prospects are said to be very encouraging. The Cinnabar King Company was incorporated in 1891, with a capital of $600,000. Their present work is mainly in the nature of development, but the President of the company stated that it was their intention to put up reduction works.

There are also five or six other places on this quicksilver belt where sufficient work is being done to keep up the assessments, and the parties interested are highly pleased with their prospects.

IRON.

Croppings of ferruginous rock and hematite, associated with decomposed shale and clayey matter, were observed by the writer in the Coleman Gulch, on G. W. Call's ranch, about 2 miles northwest from Fort Ross. The dense forest growth, however, rendered geological exploration difficult in that vicinity.

B. Elliot, of Fisk's Mill, states that a good grade of hematite is to be found about 3 miles northeast of Fisk's Mill.

KAOLIN.

A deposit of kaolinite was discovered in 1889, near Little Geyser Creek, and there is said to be a large amount of it in that locality. A sample was examined in the laboratory of the California State Mining Bureau, which showed it to be of good quality. This mineral has been ground with oil and used somewhat extensively in Healdsburg and vicinity as white paint. Its principal use is, of course, in the manufacture of pottery. The deposit is owned by H. Swift, of Healdsburg.

MINERAL PAINT.

A ferruginous tufa, which occurs near the Half-way House, between Petaluma and Sonoma, is somewhat extensively used as paint in that neighborhood, and a rock found near the base of the hills, between the town of Sonoma and Glen Ellen, is used for the same purpose.

Several years ago a company was formed to mine and prepare as paint the ferruginous cropping of a ledge on the Laughlin ranch, about 7 miles southwest from Healdsburg.

BUILDING STONE.

There is a sandstone suitable for building purposes at Fort Ross. At that place several strata, from 8 to 10 feet in thickness, are exposed on the shore and also on the mesa land skirting the ocean. This strip of mesa land was evidently the ancient shore, as the wave-worn exposures of the formation denote. The sandstone is both gray and buff colored.

The formation dips to the east of north, magnetic, at an angle of about 45°. No face has been quarried in the rock, and the stone appears at a disadvantage, for its exposed surfaces are discolored by the weathering of ages and the mists and sprays from the ocean. It is said that rock was shipped from this locality for use in building the Post Office and Custom House at San Francisco.

There is good anchorage at Fort Ross, and at present about 22 feet of water at the chute at high tide. The 3-fathom line at low water is here about 100 yards from the shore.

This sandstone was used by the Russians in 1811, in the chimney of the building now used as a hotel at Fort Ross, which is still in a good state of preservation.

A variety of trachytic tufa, similar to that mentioned as occurring in the vicinity of Napa, is also found in Sonoma Valley, and has been extensively used in that locality. A good exposure of the rock can be seen near the Sonoma cemetery, to the north of the town, where some quarrying has been done. When first quarried the stone is soft; it can be cut with an ax and dressed with ordinary sandstone tools, but it hardens on exposure.

BRICK.

An excellent brick clay is found on the banks of Sonoma Creek, to the south of Glen Ellen, and a brickyard has been established on the Malone ranch, near Madrona Station. At the time of the writer's visit

bricks were being made there to be used in building the Home for the Feeble-Minded. The erection of this home was commenced by the State in 1891, on what was formerly known as the McPherson Hill ranch, between Madrona Station and Glen Ellen.

In the vicinity of Santa Rosa there are also two brickyards, where bricks are manufactured mainly for local use.

BASALT BLOCKS AND CURBING.

The basalt block industry has greatly increased along the line of the Carquinez branch of the Southern Pacific Railroad, owing to the increased facilities which that railroad affords. Blocks of curbing stone are manufactured in the vicinity of all the little way stations, from Santa Rosa to Los Guilicos. The block makers pay from $2 50 to $3 per 1,000 royalty to the owners of the quarries. They pay 35 cents per lineal foot royalty for the curbing, and supply that f. o. b. at any of the stations in Los Guilicos Valley for 70 cents per lineal foot. It is said that the large bowlders found on the hillsides split more readily and make better blocks than the stone which is taken directly from the quarry.

The basalt block makers around the town of Sonoma report that there was a slackness of business during the year ending July, 1891, although several contracts were filled during that period. Prices averaged from $32 to $37 50 per thousand for specification blocks f. o. b. at Sonoma. The block makers consider, however, that those figures yield but little margin to the makers.

The Petaluma quarry is now owned by P. Cronin, who contemplates reopening it at an early date. A great number of blocks have in the past been shipped from this quarry, and when visited by the writer there was an immense accumulation of spalls and rubble rock suitable for macadam, concrete, or riprap work, which could be delivered in San Francisco for about $1 per ton. This quarry is situated about 400 feet above Petaluma Creek, and probably 1,000 feet distant from the wharf, where there is said to be from 16 to 20 feet of water at high tide.

LIMESTONE.

Extensive deposits of pulverulent limestone were noted by the writer in Coleman Gulch, on G. W. Call's ranch, near Fort Ross. This limestone appears to grow harder beneath the surface.

STANISLAUS COUNTY.

By W. L. Watts, Assistant in the Field.

In this county the only mining actually in progress at the time of the writer's visit was at the Summit Quicksilver Mine, on the western line of the county; although, as mentioned in previous reports, there are old quicksilver mines on the Orestimba and Adobe Creeks, upon which, it is said, the assessment work is annually performed.

Much interest has recently been excited in Stanislaus County with regard to the best route for a new road connecting the San Joaquin and Santa Clara Valleys. Such a road is especially desirable, as there is no road over this portion of the Coast Range for a distance of 80 miles, *i. e.*, from Corral Hollow to Pacheco Pass. A description is therefore appended of the route via the Orestimba Creek, from a survey made by Mr. Spurrier, of Modesto, and observations on the Puerta route, made by the writer, when journeying from the Summit Mine to Westley. A visit was also made to the irrigation construction works upon the Tuolumne River.

THE SUMMIT MINE.

The Summit Mine is now bonded by capitalists in San Francisco. Both the old and new workings at this mine are situated on the eastern side of the divide between Santa Clara and Stanislaus County, at the headwaters of one of the principal forks of La Puerta Creek.

The old workings, still open, consist of a lower and upper tunnel, and an inclined shaft. The lower old tunnel is about 200 feet above the boarding house of the Summit Mine. It has been run into the hill in a southeasterly direction, through the country rock, which at this point is principally serpentine, impregnated with silicious infiltrations and clayey matter. This tunnel is about 125 paces long. Toward its southern extremity are two small drifts. About half way from the end of the tunnel a drift about 70 paces long leads off to the southeast. Part of the tunnel is timbered and part stands without timbering. The tunnel is dry.

A little more than 100 feet above the lower is the upper old tunnel, which has been run in a similar direction. At the mouth of the upper old tunnel is an incline about 80 feet deep. This incline is intersected by a shaft about 25 feet to the east of it. A small retort is said to have been run with ore taken from this shaft. The upper tunnel is about 23 paces long; the formation is similar to that in the lower tunnel, but shows more clayey matter and ferruginous stains; it has been run in a similar direction; the vein matter at the mouth of the tunnel in some places shows crystalline cinnabar scattered through it.

About 40 feet above the upper tunnel is an outcrop of serpentine, and a short distance therefrom are outcroppings of silicious rock. The outcrop of serpentine extends along the divide with a strike of south of west and north of east, magnetic.

The new tunnels are run at a lower elevation; the first and most eastern of these is about 1,200 feet east from the old tunnels, and probably 225 feet below the top of the divide. The tunnel commences in decomposed rock and steatitic clay. The formation is traversed by silicious streaks and impregnations, and about 80 feet from the mouth of the tunnel a hard silicious rock was struck, which showed cinnabar in places. A drift was run to the southeast magnetic for a distance of about 20 feet, from a point near what was the end of the tunnel when the mine was visited by the writer; at the end of this drift a soft, light-colored serpentine was struck. The main tunnel has been continued about 20 feet farther, still in the hard silicious rock. A drift has also been run for a distance of about 24 feet in a westerly direction. Immediately at the end of the westerly drift a small vein of clayey matter and silicious rock showed considerable cinnabar, the strike being northwest by west and southeast by east, magnetic, and the dip north-northeast.

The silicious rock "slacks" and crumbles upon exposure to the air, and some of it shows iron pyrites; it is associated with steatitic matter. The tunnel is timbered at its mouth, but most of it stands without timbering; a small amount of water runs from this tunnel.

The other new tunnel is about 325 feet below the top of the divide, and probably 100 yards to the northwest of the tunnel just described. At the time of the writer's visit, this tunnel was about 145 feet in length. It commences in soft, decomposed rock, traversed by silicious streaks and steatitic matter. The formation is similar to that described in the upper new tunnel, becoming harder and more silicious as the work progresses. Some limestone was observed in this tunnel.

THE GRAYSON CLAIM.

On the east side of the cañon, and eastward from the Summit Mine, is the Grayson claim. There is a mine of similar name about 4 miles distant in an easterly direction. No work was being done on either claim at the time of the writer's visit, but cinnabar is said to have been taken from the old workings on this claim. The hill immediately east of the Summit Mine, on which the Grayson claim is situated, rises to the height of nearly 3,000 feet above sea-level.

From the divide, above the Summit Mine, to the top of the hill, are outcrops of silicious rock, and at the top of the hill there is a considerable showing of manganese.

ITINERARY, SUMMIT MINE TO SAN JOAQUIN VALLEY.

There is no wagon road eastward from the Summit Mine, but a trail descends La Puerta Creek. The headwaters of La Puerta Creek form two branches, one upon the northeastern and the other upon the southeastern base of Red Mountain. About 5 miles below the divide the barometer showed a fall of about 1,100 feet. From the Summit to Crowsdale's, a distance of about 7 miles, the formation, as seen along the trail, is serpentine, with some silicious rocks.

Between Crowsdale's and Young's metamorphic shales and sandstones were observed. At Young's, distant about 8 miles from the divide, the barometer showed a fall of about 1,250 feet. At this point

a white, decomposed serpentine crops out, penetrated by streaks of carbonate of lime. Descending the creek to Horr's the barometer showed a fall of about 1,700 feet below the divide.

The formation between Young's and Horr's is principally serpentine, with some silicious rocks, also metamorphic shale and sandstone, and at one point an outcrop of syenite was observed.

From Horr's ranch eastward, metamorphic sedimentary rocks and serpentine give place to unaltered sedimentary formations, the strike being principally northwest by southeast, and the pitch northeasterly at an angle of about 45°.

In view of the possibility of making a road from the summit of the divide down the Puerta Cañon to the San Joaquin Valley, the following elevations taken with a pocket aneroid barometer may be of interest, since the writer has been questioned by several citizens of Stanislaus County upon the subject:

Roadway at top of divide above Summit Mine	2,400 feet.
Point about 5 miles below the divide, between Adobe Creek and Crowsdale's	1,300 feet.
Young's ranch, about 1 mile from Crowsdale's	1,150 feet.
Horr's ranch, probably 6 miles from Young's	700 feet.
Jim Thompson's ranch, probably 6 miles distant from Horr's	540 feet.

Between Crowsdale's and Horr's, it is at present, for the most part, only a trail, although the settlers are endeavoring to make a roadway: below Horr's, it is a fair mountain road, the creek bed in many places affording a passage for wheeled vehicles, except in times of high water.

Below Jim Thompson's there is a good road all the way to the San Joaquin Valley, except at the Puertas, at the mouth of the cañon where the creek debouches upon the San Joaquin Valley through a break in a ledge of conglomerate. The Puertas are impassable when water is very high. The foothills between Jim Thompson's and the valley appear to be good grazing and agricultural land.

In May, 1890, a reconnoissance was made by Mr. G. Spurrier of Modesto, up the Orestimba and down La Puerta Creek, for the purpose of locating a route for a new roadway between Stanislaus County and the Santa Clara Valley.

A road has already been made from the Santa Clara Valley eastward to San Antonio Creek, and thence to the Summit Quicksilver Mine at the head of La Puertas. Mr. Spurrier's reconnoissance was undertaken with a view of solving the much vexed question as to the best way to connect with it from the San Joaquin Valley. Mr. Spurrier directed his chief attention to the question whether the better route was up the Orestimba or La Puerta Creek. A start was made at the end of an old road, near where the Orestimba Creek enters the valley of the San Joaquin. The first foothills are covered with good soil for 4 or 5 miles in a westerly direction, and in some places fragments of gypsum were observed. On these hills was a growth of grass and wild oats, but they soon gave place to a rugged formation of sandstone and conglomerate, the general strike of the formation being parallel to the axis of the mountain system. The creek had in most places cut its way nearly at right angles to the strike of the formation, forming precipitous cliffs.

The first few miles of foothills were destitute of timber, except along the Orestimba, where there are many sycamores, and along its tributary creeks, where a few cottonwood and willow were found. Some 5 or 6 miles from the edge of the plains there is a growth of brush and low

scrubby oak. At a distance of about 10 miles from the valley the cañon narrows, with precipitous sides, which in some places rise at an angle of about 60°. Here the hills are covered with oak trees of greater size, and some juniper trees, which are sought out for fence poles by the farmers of the valley. Along the creek are numerous mineral springs. The Orestimba was left at the mouth of Robinson Cañon, which was ascended in a northwesterly direction. This cañon is heavily timbered, and the mountains at its headwaters were covered with chemise.

The summit of the divide between Stanislaus and Santa Clara Counties was passed between Robinson Cañon and what is known as Red Creek, which is really one of the sources of the Orestimba. It is the opinion of Mr. Spurrier that the country traversed, although affording excellent pasture throughout a great portion of the year, is too rough for agricultural purposes. The return was made down La Puerta Cañon, which has already been described by the writer.

Mr. Spurrier is of the opinion that the route via La Puerta is the most available, it being shorter and the grade easier; moreover, it is already passable for wheeled vehicles for a distance of about 9 miles.

COPPER AND SILVER IN THE VICINITY OF LA PUERTA.

There have been several attempts at mining in the vicinity of La Puerta. A claim was located on Copper Mountain, for copper, in or about the year 1870, and a tunnel 90 feet in length was run thereon. Another claim was located as the Wild West. It is said that the ore was low grade and that no definite ledge was struck. The claims have long since been abandoned.

In 1875–76 an arrastra was operated by Mexicans in Washington Cañon, which joins La Puerta about 8 miles from the mouth of the cañon.

A silver claim called the None Such was worked in 1869, on a small branch of the Puerta, about 7 miles from its mouth. It is said that some years ago Dr. F. X. Banks discovered a vein of low-grade silver ore in Ingram Cañon.

IRRIGATION.

The Turlock and Modesto Irrigation Districts have entered into a contract to build a joint dam a short distance above the old Wheaton dam upon the Tuolumne River, above La Grange. This dam as designed will be about 105 feet high, 100 feet thick at the base, and 20 feet at the top. The base will follow the contour of the river bed, which at that point is 350 feet from bank to bank. The dam, which was in process of construction at the time the locality was visited by the writer, will be built of stone.

THE TURLOCK IRRIGATION DISTRICT.

About 17 miles of the main canal of this district were already constructed in April, 1892, from about 1 mile above La Grange to the boundary of the district, about 1,200 feet being still required to make connection. The main portion of the canal is 70 feet in width at the bottom and 7½ feet deep; the grade is about 2 feet to the mile.

THE MODESTO IRRIGATION DISTRICT.

This district will divert water from the Tuolumne River at a point on its northern bank. The main canal is divided into sections, four of which have already been determined; these will bring the canal down to the eastern boundary of the district. Of these sections, at the time of the writer's visit, one was practically completed and two in course of construction. The canal will be 80 feet wide at the bottom, 100 feet at the top, and 8 feet deep.

A visit was made by the writer to the construction works of the Modesto Irrigation Company at La Grange. At the dam the formation is quartzite, which a little farther westward shows a contact with the slate. Upon the contact some quartz vein matter is exposed, and at one time some prospect working was done. Westward, toward La Grange, the formation is slate, the strike being generally west of north and east of south, magnetic, and at several places shows local disturbance. A little west from La Grange the cutting penetrates a fine quartz breccia, the cementing material being principally silica and oxide of iron; the breccia appears to be overlaid by a light-colored sandstone, probably resting unconformably upon the slate. Farther westward the cutting penetrates an alluvial formation, and a soft arenaceous conglomerate passing into soft micaceous sandy strata, both formations containing enough clayey matter to set under the action of the atmosphere. Farther west the sandy strata are harder, and are in places interstratified with gravelly clay and drift; at one point, also, the formation is an impalpable micaceous sand, containing some clayey matter. The stratification is irregular.

The first portion of the cutting ends at a ravine, where the formation changes to a trachytic tufa. This tufa extends for several miles in a westerly direction, and in some places is evidently upwards of 200 feet in thickness. Upon its surface are several low hills of gravel and cement, and it is through one of these that a tunnel is being made by the Modesto Irrigation Company. The upper portion of this is apparently a trachytic lava, sometimes slightly vesicular, and at one point micaceous trachyte was observed. The lower portion of this trachytic sheet is well exposed upon the west bank of the Tuolumne River, about 3 miles west of La Grange, where a small quarry has been opened. The stone is soft when quarried, but is said to harden by exposure. The upper portion of the quarry is composed of partially decomposed pumice, cemented together with feldspathic matter, and the lower strata is of grayish tufa, containing fragments of pumice and carbonaceous matter. The formation is practically horizontal. Exposures of the rock at a lower elevation show other lines of pumiceous tufa, intercalating more compact strata containing clayey matter, showing fine lines of sedimentation, which give evidence of the tranquil water into which the volcanic ejectmenta fell.

WELDING SAND.

R. Huntley, living about 3 miles west of La Grange, obtained a fine sand when boring a well upon his ranch, which is said to facilitate welding. It is used by himself and other blacksmiths in the vicinity. It appears to be the most efficacious when mixed with about one third its weight of borax.

SUTTER COUNTY.

By W. L. Watts, Assistant in the Field.

A perusal of the following notes will show that Sutter County is for the most part well provided with subterranean water at no great depth; but the writer could not learn of any flowing wells in the county, nor of any very deep borings. Natural gas has been discovered in many places in Sutter County at an insignificant depth.

The somewhat auriferous nature of portions of the Cretaceous formations and derivative gravels around the Marysville Buttes call to mind similar formations in Colusa County. As far as the writer's observations have gone, the oldest fossiliferous rocks around the Buttes appear to belong to the Chico Tejon series, or Cretaceous B, and they are elevated at a great angle.

WATER.

Along the western side of the Feather River wells average about 40 feet in depth, the formation being a blackish, sandy loam from 4 to 20 feet thick, underlaid by sand and gravel, which has been penetrated for 45 feet. The gravel becomes coarser toward the bottom, and yields an inexhaustible supply of water. Above the gravel, quicksand is troublesome, but it can be cased off.

Around Yuba City, including the town plot, and about 1 mile south therefrom, the formation is remarkable for sudden changes within a short distance. Thus, within the town plot, the formation usually observed is surface loam, from 4 to 20 feet, beneath which sand has been penetrated to a depth of more than 120 feet. Usually there is plenty of water in the sand at a depth of from 35 to 40 feet, but sometimes there is no supply until a much greater depth is reached. Thus, half a mile south of Yuba City, near the cannery, a well was sunk in which the sand was penetrated for 100 feet before a supply of water was obtained.

In close proximity to the above, the formation changes to blue clay. At the Yuba City Court-house a well showed:

Sandy surface loam	4 feet.
Quicksand	6 feet.
Blue clay, which was bored through for	70 feet.

Numerous pieces of wood and strata of decayed leaves were passed through in the blue clay. The water in this well was brackish. In the northern part of the town the supply of water is excellent, and it stands within 8 or 9 feet of the surface.

The Yuba City Waterworks obtain water from two wells—one 8-inch well, which is 126 feet deep, and one 10-inch well, of less depth. They pump 175,000 gallons a day during the summer, and about 50,000 gallons during the winter, without perceptibly lowering the water, which stands at a depth of about 12 feet from the surface.

Throughout the northern part of the county, at a distance of abo

miles from the Feather River, the surface soil is usually adobe for about 2 feet; beneath it is hardpan, about 4 feet, and yellow clay from 30 to 50 feet in thickness; beneath the yellow clay is sand and gravel, with plenty of water. Sometimes, however, the yellow clay is much thicker; in one instance, about 6 miles northwest of Yuba City, it was penetrated for 200 feet. A similar experience was had in a well on an island in the Sacramento River, in Reclamation District No. 70. This excited the surprise of the well-borer, because usually along the bank of the Sacramento, in Sutter County, excluding the tule lands, plenty of water is obtained in gravel, at a depth of about 45 feet, after penetrating a sandy sediment soil of from 10 to 25 feet in depth.

The writer was informed that in the northern part of the county, except in the vicinity of the Buttes, an immense supply of water can be obtained at a depth of about 70 feet, and that a 7-inch well, which was bored to the depth of 69 feet, about 7 miles west from Feather River, yielded ample water for a pump throwing 20,000 gallons an hour; moreover, that prolonged pumping only lowered the water about 4 inches.

Toward Marysville Buttes water is scarcer and the wells deeper; the surface soil is a sharp, gravelly clay, which, within a few feet of the surface, becomes much mixed with broken rock. Around Sutter City, however, borings have shown:

Gravelly loam	18 to 22 feet.
Quicksand, with water	1 to 2 feet.
Yellow clay (the bottom of this stratum contains numerous pebbles)	18 to 20 feet.
Coarse gravel with plenty of water, which rises to within 18 or 20 feet of the surface	2 to 3 feet.
This gravel is frequently auriferous, showing sometimes a color to the pan, but the gold is light and flaky.	
Yellow clay	12 feet.
Clean washed gravel	3 to 4 feet.

This gravel yields an immense amount of water; a pump throwing 6,000 gallons per hour failed to lower the water from this stratum.

Beyond the radius of a mile from Sutter City, the water plane rises to the southeast, until a good supply of water is obtained at a depth of 12 to 13 feet; the first stratum of gravel usually shows a color of gold to the pan.

About one mile south of Sutter City, on the Davis ranch, a well was bored on a knoll to the depth of 35 feet. After passing through a gravelly soil overlying an adobe and a loamy stratum, coal was struck, but the writer could not learn any particulars with regard to its thickness. The water in the well was said to be bad, although all around the knoll good water could be obtained at a depth of from 10 to 12 feet.

Throughout the tule lands along the Sacramento River, in Sutter County, the water is generally brackish; the formation observed has been generally similar to that noted by W. H. Parks, who, several years ago, bored two wells on his ranch in the tule lands 6 or 7 miles south of the Marysville Buttes. One of these wells was a 4½-inch well, 195 feet deep, and the other a 4-inch well, 395 feet deep. The formation is as follows:

Surface soil (rotten tule and loam)	12 feet.
Hardpan	1 foot.
Alternate strata of blue clay and whitish sand	195 feet.

At this depth a pine log was bored through, in a stratum of blue and white quartz gravel, a few feet thick. Beneath the gravel, strata of

sand and blue clay alternated to the bottom of the well, which is 395 feet deep. There is plenty of water, but it was brackish and of no use.

COAL.

A company was formed in 1858 to prospect for coal in the Marysville Buttes, and some work was done on the ranch of Newcomb & Hause, in the southern portion of the Buttes. A shaft about 15 feet in depth was sunk and a drift of 100 feet run. The formation is clay and sandstone, and is said to have "smelled strongly of gas." No regular vein was struck, but a few bushels of coal were taken out, which is said to have burned well.

A shaft was also sunk on the Moody ranch, at the foot of the Southeast Butte, to a depth of 150 feet. The formation is:

Clayey soil	12 feet.
Gray and white clay	8 feet.
Slate-colored shale, with pockets of coal	123 feet.

The shale showed the impressions of numerous leaves, some of which are said to have resembled oak, and others peach leaves. The shale was traversed by numerous small seams of coal, 2 or 3 inches in diameter. The formation pitched at a great angle.

Coal is also said to have been struck on the Davis ranch, about 1 mile south of Sutter City, as noted under the head of "Wells"; and croppings of coal are said to have been prospected on the Pugh ranch, on the northern slope of the Buttes.

POTTERY CLAY AND CEMENT.

Pottery clay is found in several places on the slopes of the Marysville Buttes; and it is said that limestones and clays, which analysis has shown to be suitable for the manufacture of cement, are also found there. A company was organized in San Francisco in 1891 as the Sutter County Cement Company, the intention being to manufacture Portland and Roman cement, fire-brick, terra cotta, and stoneware. What active steps have been taken in the enterprise the writer had not learned at the time of this writing.

GOLD.

The gravels of some portions of the Marysville Buttes are auriferous. They have been worked in a desultory manner for many years when water was to be obtained, and fair wages are said to have been earned thereby.

Some prospecting was done in 1890 on the Western Butte, and the channel of an old creek on the Tarkey ranch was explored. The gravel from the channel of this creek showed from one to twenty colors to the pan. The largest piece of gold obtained is said to have been worth a little more than $1, while some pieces were worth about 10 cents; most of the gold was "light gold," ranging from the size of a pin's head down.

Washing and sluicing were being prosecuted to a limited extent on the Graves ranch when the writer visited the Buttes in December, 1891. Quartz ledges are also said to exist in some portions of the Buttes, but the writer was informed that assays of the croppings have shown only traces of gold.

TEHAMA COUNTY.

By W. L. Watts, Assistant in the Field.

In this county the attention of the writer was mainly directed to the water-bearing formations of the valley lands; and for the following particulars he is indebted to Mr. Gernon, the County Surveyor, Mr. H. Polsley, and other gentlemen who have made a study of the alluvial formations of Tehama County.

With regard to the alluvial and volcanic formations in the valley lands of Tehama County, Mr. Gernon says:

"On the eastern side of the Sacramento River, tufa (volcanic ashes and lava) predominates. On the western side of the river, and in some places on the eastern side, the volcanic rocks are capped with clay, clay loams, gravel, and sandy strata.

"The Sacramento River runs along the eastern contact of the clay loams and volcanic rocks throughout the length of the county, except at the two bends of the river between Jelley's Ferry and Red Bluff, in each of which about 1 square mile of the volcanic formation lies on the western side of the river. On the surface the dip of the volcanic formation is to the west at an angle of about 3°. How deep this formation sinks I do not know, but it reappears on the western side of the valley at an altitude of 800 feet, where a stratum of tufa lies on the eroded and upturned ends of strata of shale and sandstone. This stratum of tufa is about 60 feet thick. Overlying the tufa is a light-colored clayey formation, which also contains some sand. It has a depth of more than 500 feet and stands in vertical banks fronting the creeks. In this formation thin strata of sand, sometimes containing small pebbles, occur at intervals; they are not continuous sheets, however, but pinch out in the clay. This is why the chances of obtaining water in wells penetrating this formation diminish below a depth of 80 feet. In these light-colored clays the water-bearing strata have no connection with the surface. The western outcrop of these light-colored clays is what is known as the Bald Hills, or Oat Hills. When first put in cultivation they appear somewhat dark in color, but soon grow white by continued tilling. They raise grain abundantly, but do not produce other crops in paying quantities.

"The eastern outcrop of this formation forms the white clay plains. On the top of the light-colored clayey formations is what I believe geologists call till. It is composed of red clay and gravel and runs across the valley in ridges from southwest to northeast like great dams, the largest of which is the Hooker Divide. These ridges are generally flat on top and form the mesa lands of Tehama County. A striking peculiarity of this formation is the hardpan, which is from 6 to 30 inches below the surface and is from 8 to 16 inches thick; it is composed of waxy red clay, in which pebbles are imbedded and packed so tight that no water can sink through it. On the top of the hardpan are hillocks

from 16 to 20 inches high and 15 to 30 feet in diameter, called cradle-knolls; between the cradle-knolls are little ponds, called hog-wallows. These lands are unproductive.

"In Tehama County the creeks enter the river in pairs; Cottonwood and Battle Creeks make a pair, Red Bank and Antelope Creeks make a pair, Elder and Mill Creeks make a pair, Thome's and Deer Creeks make a pair, and Stony and Chico Creeks make a pair. Some of these creeks, as Antelope and Mill, have made new channels, entering the river farther south than they formerly did.

"The slope of the valley on the west side of the river in Tehama County is to the southeast, but the creeks run to the northeast. If you are drawing a map of Tehama County and guessing where a creek runs, turn it north instead of south and you will be right nine times out of ten. The channels of the creeks are filling up with gravel for the last 15 miles of their course. This has been going on, in the case of Thome's Creek, for a time sufficient to make a bed of gravel 60 feet deep and half a mile wide. In the summer, when the channel of Thome's Creek is dry, a large quantity of water finds its way beneath this gravel to the Sacramento River.

"At Henleyville, I have known Thome's Creek to flow in a stream 30 feet wide and 2½ feet deep for three months, during which time no water reached the Sacramento River by flowing over the gravel in the channel of this creek. That this water was evaporated is not consistent with the facts observed.

"In the Coast Range, at the 1500-foot level, there is a stratum of rock containing many sea shells. This stratum appears to absorb nearly all the water of the creeks which cross it."

THE WELLS OF TEHAMA COUNTY.

For the following description of the wells of Tehama County, the writer is indebted to Mr. H. Polsley, of Red Bluff. The wells referred to were either sunk by him or received his especial attention:

The town of Red Bluff is situated on a bluff about 70 feet above the Sacramento River. Beneath the surface soil is a stratum of cement gravel, which is about 16 feet in thickness, then clay for a depth of 30 to 160 feet. In some parts of the town water is found in cement gravel on the top of the clay, in other parts below the clayey stratum. In a few instances this stratum of clay has not been penetrated by boring 160 feet. In a well bored at the California Bakery, the formation is as follows:

Red loam	8 feet.
Cement gravel	13 feet.
Sandy clay	27 feet.
Fine blackish gravel and sand, with water	5 feet.

The water rose 6 or 8 feet in the well. When the gravel was first struck, a loud bubbling and hissing noise could be heard for several minutes, but no current of air or gas was observed.

A few years ago a well was bored at Red Bluff, on the hospital grounds, and Mr. Polsley states, that as he paid particular attention to the matter, the following, although from memory, is approximately correct. It is a 7-inch well, and the following formation was passed through:

Red gravelly soil	5 feet.
Cement gravel and cobbles	30 feet.
Yellow clay	55 feet.
Quicksand, with water rising 30 feet	4 feet.
Sandy clay	30 feet.
Red sand and small gravel	20 feet.
Whitish clay, with layers of white rock	56 feet.
Sandy clay and sand	50 feet.
Whitish clay	20 feet.
Rock, apparently lava	22 feet.
Depth of well	292 feet.

The well was cased with 14-inch iron casing.

Another well was subsequently bored, 10 inches in diameter, and cased with wrought-iron pipe, with screw joints, but the contractor failed to complete it. The Supervisors who measured the well came to the conclusion that it was about 468 feet in depth. The water rose to within 40 feet of the top of the casing.

Another well was sunk at the County Hospital to supply a windmill pump. The formation is:

Red gravelly soil	5 feet.
Hardpan, with cement, gravel, and cobbles	30 feet.
Yellow clay	55 feet.
White quicksand and strong head of water rising 32 feet	2 feet.
Depth of well	92 feet.

This last mentioned well was dug 70 feet, and a small supply of water found; afterward a 6-inch hole was bored in the bottom, through which the water rose, filling the dry portion of the well to a depth of about 12 feet.

On the property of G. G. Kimball, in the south part of the town, a well was dug on the bank of the river to a depth of about 50 feet; this was done about thirty years ago, and no record preserved. As the well did not furnish sufficient water, a boring was made in the bottom, and the following strata penetrated:

Soft tufa	8 feet.
Quicksand, with water rising 16 feet	2 feet.
Whitish clay	24 feet
Gravel	5 feet.
Clay	11 feet.

The bottom of the well is about 60 feet below the surface of the river at its lowest. The quicksand at 60 feet gave a good supply of water for a pump run by a two horse-power gas engine.

At the school house, in the northwest portion of Red Bluff, the top soil was found to be 6 feet thick; beneath it was a hard cement, with cobbles 13 feet in thickness; beneath the cement the stratum of clay was penetrated for 140 feet, but no more water was found.

In 1887 a well bored on the ranch of Mr. E. R. Hughes, on Pine Creek, showed:

Gravelly soil	15 feet.
Clay	40 feet.
Coarse, round gravel	10 feet.
Clay, interstratified with cement rock	25 feet.
White clay, with sandy cement rock	10 feet.
White cement rock	60 feet.

The amount of water at this depth was so small that the well was abandoned. A small supply of water was afterwards obtained upon the surface of the first stratum of clay, by sinking another well about 50 feet from the first.

Two wells were bored on the ranch of J. L. Burt, in the hills between Eliza and Reed's Creeks, about 150 feet above the creek, and probably 2 miles south of the Hughes ranch. The top soil was adobe, and about 6 feet in thickness, beneath which is 14 feet of clay; beneath the clay the auger penetrated volcanic ash and strata of dry gravel and clay for 97 feet, but no water was found. South of this well several wells were sunk on N. J. Cromwell's ranch on Reed's Creek, the deepest being 196 feet; only a small amount of water was obtained. West from these places water is found at a depth of 30 or 40 feet. Also a mile or so to the eastward there is plenty of water at a depth of about 20 feet.

Fifteen miles west of Red Bluff, in Sec. 6, T. 27 N., R. 5 W., M. D. M., a well was sunk on Dibble Creek, and the following formation noted:

Gravelly soil	4 feet.
White and yellow clay, with strata of cement rock	56 feet.
Hard cement rock	2 feet.
Strata of dry porous clay with white rock and gravel, but no water	134 feet.
Depth of well	196 feet.

In this neighborhood people depend upon cisterns for water. Near the headwaters of Reed's, Eliza, Dibble, and Hooker Creeks, numerous wells have been sunk without obtaining a good supply of water. The cañon of the South Fork of Cottonwood Creek extends to the north and west of this district, and the bed of the creek is very much lower than the surrounding country, which it probably drains.

On Manzanita Flat, at the head of Hooker Creek, the following wells were sunk: On the ranch of J. M. Coon, 164 feet; no water. On the ranch of E. F. Lohman, 213 feet; no water. On the ranch of T. Hoerning, 90 feet; no water.

On the Wallbridge ranch water was struck at a depth of 255 feet, which rose 50 feet in the casing; the formation in all these wells is hardpan, passing into sandy clay.

On the ranch of H. Polsley, in Sec. 32, T. 28 N., R. 5 W., M. D. M., some 90 feet lower than Manzanita Flat, the formation is as follows:

Gravelly adobe	13 feet.
Whitish clay	40 feet.
Cement rock mixed with clay	2 feet.
Yellow clay, occasionally interstratified with cement rock	30 feet.
Sandy, porous clay with smooth white gravel	153 feet.
Depth of well	238 feet.

No water was found in this well, although the clay was damp. Sixty feet from this boring, a dug well 12 feet in depth furnished a small supply of water.

One and a half miles down Dibble Creek from the Polsley ranch a well was bored on the property of G. Wallhead, to the depth of 131 feet. A similar formation was observed, but at a depth of 123 feet a reddish gravel was struck, which yielded a plentiful supply of water. Farther down the creek the water plane is shallower; at a distance of about 2 miles it is only 56 feet to water; another mile lower down only 48 feet, and at a distance of about 5 miles down the creek from the Polsley

ranch, there are springs of water coming out of the bank of the creek, and a good supply of water can be obtained at a depth of 4 or 5 feet.

In a well bored on the ranch of G. Wright, on Live Oak Creek, water was struck in a stratum of quicksand beneath about 30 feet of yellow clay; the water rose about 18 feet in the casing.

A well was bored on the ranch of M. R. Hook, about 1½ miles west of Red Bluff; in it yellow sandy clay was penetrated for 88 feet, beneath which plenty of water was obtained from a stratum of blackish gravel about 8 feet in thickness.

A well was bored about 8 miles west of Red Bluff, on the Andrew Johnson ranch, near Reed's Creek, the bank of the creek being about 16 feet lower than the well. The following formation was observed:

Sandy loam	18 feet.
Loose gravel, with water	4 feet.
A perforated 6-inch casing was put in here.	
Yellow clay	58 feet.
Quicksand, with water, which rose to within 8 feet of the surface	3 feet.
Depth of well	83 feet.

The well was left without casing other than the 4 feet of perforated casing above mentioned. Had it been properly cased, it is the opinion of Mr. Polsley that the water would have risen to the surface.

On the ranch of G. McCoy, on the Middle Fork of Dibble Creek, a well was dug through clay to a depth of 60 feet. It was then decided to bore a prospect hole with a 2-inch auger in the bottom of the well; after boring about 10 feet a bed of gravel and quicksand was struck, from which the water rose with great rapidity and filled the well to the depth of several feet.

A well bored on the G. M. Howell ranch, near Henleyville, about 18 miles southwest of Red Bluff, on Thome's Creek, showed:

Loam	10 feet.
Quicksand, with water	8 feet.
Clay	17 feet.
Gravelly clay, with water	5 feet.
Hard clay	50 feet.
Gravel, with water	6 feet.
Depth of well	96 feet.

A 7-inch casing was put through the upper water-bearing stratum, inside of which the well was cased with 6-inch casing, and cement was "run in" between the casings to shut off the surface water. In this well the water stood at about 35 feet from the surface.

At the Lowry school house, 25 miles south from Red Bluff, near the head of Elder Creek and westward from the Gallatin ranch, a well showed this formation:

Gravelly soil	8 feet.
Cobbles	7 feet.
Slaty rock, with some water	10 feet.

In this vicinity there are a number of thin veins of good coal, seldom more than an inch or so in thickness. The casing of this well became filled with small shells.

At the Farquhar school house, on the north side of the South Fork of Cottonwood Creek, about 25 miles northwest of Red Bluff, the formation penetrated was soil, clay, and gravel to a depth of 48 feet, where

some water was found. Below this was 16 feet of hard, smooth, white, oily-feeling clay, without any grit; below this clay was 5 or 6 feet of water-bearing gravel. This well is probably 50 feet above the level of the creek bed.

WELLS IN VICINITY OF HOOKER.

The divide upon which Hooker is situated is the highest in Tehama County, south of Cottonwood Creek. It extends in a northeasterly direction from the head of Reed's Creek, across the valley as far as the Sacramento River. The formation to within 2 or 3 miles of the S. P. R. R. is one great bed of clay, several hundred feet deep; as the railroad is approached, the formation changes to volcanic ash and gravel.

East of Hooker the ridge increases in height, but on the summit is a fine orchard, the soil being red loam and about 10 feet deep. Formerly this land was covered with a dense growth of chaparral, manzanita, and "digger pine." The hills appear to be formed of soft tufa, and but few springs are found. At the orchard above mentioned, C. L. Confer dug a well to the depth of 180 feet; he also formed a storage reservoir by building a dam across one of the gulches on his ranch. By this means he has plenty of water for his stock the year round.

On the ranch of E. E. Rogers, about 2 miles west of Hooker, a well showed:

Gravelly soil	15 feet.
Cement gravel and cobbles	40 feet.
Clay	20 feet.
Gravel	5 feet.
Dry volcanic sand and ash	10 feet.
From this sand a current of air rushes when the wind is in the south, and when the wind is in the north a current of air is drawn into the formation.	
Clay	25 feet.
Coarse sand, with plenty of water	10 feet.
Depth of well	125 feet.

This well is on the north side of the ridge. There are several other wells in this neighborhood which act in a similar manner.

At the Hutchinson ranch, about a quarter of a mile east of Rogers', a well was bored on a hill about 60 feet high; the formation is:

Alternate layers of cement, gravel, and clay	80 feet.
Dry, fine sand, from which air issued	6 feet.
Clay	5 feet.
Volcanic sand and gravel	71 feet.
Coarse, white sand, with a good supply of water	6 feet.
Depth of well	168 feet.

On the south side of the ridge, at the Eldridge ranch, near Hooker, a well was sunk through:

Adobe soil	5 feet.
Gravel	15 feet.
Clay	4 feet.
Volcanic gravel and sand	24 feet.
Reddish sand, with a little water	2 feet.
Gravel and sand, alternating with porous clay	66 feet.
Depth of well	116 feet.

The water seeped from the clay below a depth of 100 feet; the pores in the clay were many of them nearly half an inch in diameter.

WELLS ON EAST SIDE OF SACRAMENTO RIVER.

On the Barenda tract, about half a mile from the river, and 2 miles from Red Bluff, a well showed:

Sandy loam (in this a small Indian ornament was found at the depth of 6 feet)	10 feet.
Cobbles and washed rocks	4 feet.
Dry sand	4 feet.
Large bowlders, weighing several hundred pounds	6 feet.
Soft tufa	6 feet.
Clay	30 feet.
Depth of well	60 feet.

Very little water was found in this well. A quarter of a mile south of the above plenty of water was found at a depth of 24 feet.

In the vicinity of Vina the country is quite sandy, and before irrigation the water stood at 25 or 30 feet from the surface; it now stands at from 10 to 12 feet.

At Copeland ranch a well was sunk through:

Sandy loam	8 feet.
Loose gravel, with poor water	12 feet.
Yellow clay	4 feet.
Gravelly clay	5 feet.
Lava	5 feet.
River gravel, with good water	6 feet.
Depth of well	40 feet.

At the winery the formation was:

Soil	15 feet.
Quicksand and water	8 feet.
River gravel	7 feet.
Lava	6 feet.
Depth of well	36 feet.

The water from this well was not good.

At the winery boarding house a sandy loam was passed through for 12 feet, and a quicksand for 8, when 5 feet of river gravel was struck, which yielded good water. As a rule the water found in the quicksand at Vina is not good, but that found in the river gravel is.

At the Hildebrant Hotel the soil was found to be 8 feet thick, beneath which was 10 feet of sand with water, and 17 feet of gravel and quicksand, from which a good supply of good, clear water was obtained.

Eastward from Vina there is a layer of lava a few feet in thickness, and at one point it extends nearly to the village of Vina. The lava, which seems to have run down a river bottom, is but little higher than the surrounding country.

SUBTERRANEAN AIR CURRENTS IN TEHAMA COUNTY.

Mr. Gernon, the County Surveyor, and other citizens of Tehama County, state that they have frequently observed currents of what is believed to be air in wells in the western portion of the valley lands of Tehama County, in what is called the adobe and chaparral hill country. These currents of air are found to escape from and to be drawn into strata of sand or dry porous clay. The direction of these air currents appears to depend on the condition of the atmosphere. Water is often

found a few feet below the top of the air-yielding stratum. When the water is first struck it is sometimes blown in bubbles through the clay or sand. When a little water has accumulated in the well, the air bubbles through it, but as soon as the water becomes a few feet deep the ebullition ceases, although sometimes a current of air still issues from or is drawn into strata above the water-level. It is so in a well that is bored on the ranch of Mr. E. Fish, about 2 miles west of Red Bluff. This well emits a current of air previous to a rain, and draws in the atmosphere as fair weather approaches. This current of air issues from or is drawn into a bed of dry sand at a depth of 110 feet. The top of the well is covered, with the exception of a small hole which is furnished with a whistle; and it is said that before a storm the whistle can be sometimes heard for half a mile.

The strongest flow of this "gas or air" has been observed in the deepest wells; and when struck at a depth of 150 feet it escapes under considerable pressure, producing a hissing noise. At first the influx of air was not observed, and the escaping air was supposed to be gas. Attempts were made to ignite it, but without success, and since it occasions no inconvenience to well diggers, it is believed to be air.

IRRIGATION.

Irrigation in Tehama County is represented by private enterprises. Several attempts have been made to form irrigation districts under the Wright Act, but the proposition has always been defeated.

The irrigated tracts on the eastern side of the Sacramento River are: The Stanford ranch, where some 7,000 acres are irrigated by water diverted from Deer Creek, and about 4,000 acres of orchard land on Deer Creek, which are irrigated by water from that stream. At the Sesma tract, some 400 acres of orchard and garden are irrigated from Mill Creek. In Antelope Valley, at the Cone ranch, some 25 acres are irrigated from Antelope Creek. At the Manton Settlement, which lies on the west slope of the Sierra, at the height of from 1,800 to 3,000 feet above sea-level, some 800 acres are irrigated by various ditches carrying water from Digger Creek, the difference of level being sometimes as much as 1,200 feet.

On the western side of the Sacramento River, the Corning Irrigation Canal takes its water from Thome's Creek and flows across a divide through Squaw Hollow to Corning. A company has also been organized as the Thome's Creek Irrigation Company, and it is estimated that they will divert enough water from Thome's Creek to irrigate about 4,000 acres. Farther back in the foothills, in R. 6 and 7 W., water is diverted from Elder Creek by settlers along its course.

TRINITY COUNTY.

By R. L. DUNN, E.M., Assistant in the Field.

Trinity County takes its name from the river of the same name, which was supposed by its discoverer, Major Reading, to empty into Trinidad Bay, a few miles north of Humboldt Bay. It is a very mountainous county, having only a few small and scattered tracts of level land situated in narrow mountain valleys. Lying in the heart of the Coast Range, its mountain system is irregular and complex. Its eastern and northern, and the northern half of its western, boundaries are the summits of mountain ranges, continuous except where cut through at one point on the western boundary by the Trinity River. On the east the summit forms the watershed separating the Sacramento River drainage basin in Shasta County from the Trinity. On the north it separates the drainage basin of the Trinity from the drainage basins of the Salmon, Scott, and Shasta Rivers lying in Siskiyou County. On the west the county is bounded by Humboldt County and on the south by Mendocino County. All of it, except the extreme southern and southwestern portions, drained by Eel and Mad Rivers, is drained by the Trinity River and its numerous tributaries. While the boundary ranges of the county, with the exception of the Salmon range, a portion of the north boundary, have a general northeasterly course, the numerous ranges in the interior of the county have a northwesterly trend, crossing it from the east boundary to the north.

The value of Trinity County is almost exclusively in its mineral resources. Its agricultural resources are very insignificant, and insufficient for the supply of its mining population. The inaccessibility of the county precludes the utilization of its considerable forests of timber commercially, and also limits its mineral production to gold and quicksilver. Wagon roads penetrate the county at only three points. For many years all the passenger and freight traffic between California and Oregon passed through the northeastern corner of Trinity County. The road crossed the Trinity range a few miles north of the town of French Gulch, in Shasta County, followed up the cañon of Trinity River through the town of Trinity Center, and crossed Scott Mountain into the Scott Valley of Siskiyou County. At the present time a considerable portion of the staples consumed in Trinity County comes over this road from Scott Valley. The only other road into the county is the Redding and Weaverville road, crossing the Trinity range west of French Gulch.

Though Trinity County covers a large area, its mineral resources occupy only a fraction of the northern half. It is the difficulty of intercommunication that gives them an apparent wide superficial extent. In the consideration of Siskiyou County it was pointed out that the mineral rock system of the section of Northern California including Siskiyou, Trinity, and Shasta Counties consisted of four belts having a common

strike or general direction, but separated by zones of rock barren of valuable mineral. Three of these belts enter Trinity County. The southwestern end of the second or main Siskiyou belt is the New River District of northwestern Trinity. The third belt lies mainly in Trinity County, having its southern end in East Fork and Cañon Creek Districts, and running thence northeasterly across the mountain ranges and headwaters of the west branches of the Trinity, and into Siskiyou County at the headwaters of the South Forks of the Salmon and Scott Rivers, where it disappears. Most of the fourth belt is in Shasta County, but the portion of it in Trinity comprises Bully Choop, Deadwood, Tamarack, and Altoona Districts.

The placers of New River were formed from the erosion of the first described belt, and the placers of Deadwood, Grass Valley, Indian, and Reading Creeks from the last described. The great body of the placers, however, came from the erosion of the second described belt. Its southern end is deeply eroded by the East Fork of the North Fork and Cañon Creek. Stewart's Fork, Swift Creek, and Coffee Creek cut into it from the east. Prior to these in point of time is the earlier erosion, which formed the auriferous drift gravels deep buried in the ancient bed of the Trinity several hundred feet above its present channel. From these noted streams, and the secondary erosion of the ancient channel by Weaver Creek, Button's Creek, and Oregon Gulch, have come the auriferous gravels which have formed the river, bar, and bench placers of the main Trinity. The extent and richness of these placers are remarkable when the small area of auriferous rock belt from which they have been eroded is considered.

Very full detailed descriptions of the mines of Trinity County have been given in the Mining Bureau reports of 1888 and 1890. Since the last the mining industry has been maintaining itself at about the same mark, so far as the annual output and development of mines is concerned. The change, if any, is very slight, and is due to the gradual working out and abandonment of the Weaverville placers.

The placer mines in all the smaller streams and cañons, except Oregon Gulch, are at present practically worked out. On the main Trinity the low bars and river-bed placers are gone, and though considerable areas of the bench gravels remain, the yield from them is certain to show a gradual decrease. The permanence of the placer mining industry is dependent on the working of the large areas of unworked hydraulic ground in the vicinity of Trinity Center and Oregon Gulch.

The quartz mining industry is of comparatively recent growth in Trinity County. Only one district, Deadwood, has been exploited to any great extent. Bully Choop, New River, East Fork, and Tamarack have had periods of activity and periods of depression; but comparatively little development work has been done in any of them, though at times they have all, except the last named, been producers. Cañon Creek District, the development of the last two years, is, next to Deadwood, the leading district in the county. In it a number of promising mines are being opened, which are already making a considerable yield of gold.

The several mining districts of the county are the following: New River, East Fork, Cañon Creek, Deadwood, Bully Choop, and Tamarack, all quartz mining districts; Trinity Center, Weaverville, Oregon Gulch,

OTHER DISTRICTS.

Bully Choop and Tamarack Districts have not been mined during the year. Only assessment work and some prospecting have been done.

At the head of Stewart's Fork there are some quartz locations on large ledges, but nothing has been done with them. One or two discoveries of ledges are also reported near the head of Coffee Creek, but no notable developments have been made as yet.

On Scott Mountain, close to where the road crosses, coarse, heavy gold has been found, its source being probably in some undiscovered quartz ledge close at hand.

JUNCTION CITY DISTRICT.

Owing to a good water season, the production of the hydraulic mines in the vicinity of Junction City has been larger for 1892 than for a number of years preceding. There are no changes in the mines, all of which have been reported on individually in the report of 1890. No new water supplies have been brought in. The areas of unworked ground are very considerable still and cannot be worked out for many years. There is no reason to anticipate any considerable reduction in production of these mines for some years.

WEAVERVILLE DISTRICT.

The placers around Weaverville are very nearly worked out; only a few years' washing yet remains. Most of the mining now is being done by Chinese. For the year 1892, the indications were, at the time of my examination, that the aggregate production would be close to $90,000. It will likely diminish rapidly for the next few years.

The Ward Hydraulic Mine, owned by Paulson & Leveridge, and situated at the head of Oregon Gulch, is now well opened for hydraulicking. For several years this claim has been operated at a disadvantage, now removed. Two pits are being worked, one above the other. The gold does not occur in seams or leads, but is uniformly distributed throughout the mass of the ground. In 1891, the upper pit with one head (1,000 inches) of water, run three hundred and twenty-six hours, and paid $7,000. In the lower pit a double head of water being used, 1,700 to 2,000 inches, for four hundred and fifty-three hours' run, the pay was $6,400. This is at the rate of $518 for a twenty-four-hour run. For the year 1892, estimating from the production up to the time of my visit to the mine, it is expected that the yield of the mine will be certainly $25,000, and may go to $30,000. With an adequate water supply this mine would be a large producer of gold indefinitely, for the mass of auriferous ground is of enormous extent.

TULARE COUNTY.

By W. L. WATTS, Assistant in the Field.

One of the most prominent features of the physical geography of the San Joaquin Valley is Tulare Lake. This lake was, no doubt, originally formed by the accumulated drift from Kings River intercepting the drainage from the upper portion of the San Joaquin Valley.

As is shown by the successive surveys delineated upon the irrigation map of the Great Central Valley of California, Tulare Lake is gradually shrinking, and it has been estimated by other observers that, at the end of the present century, the area of the lake will probably not exceed 50 square miles. The reason of this shrinkage is, no doubt, the diversion of a large amount of water for irrigation from tributaries of the lake, while loss by evaporation and seepage still continues. Under these conditions, the amount of solid matter contained in the water of the lake is increasing, and at the present time its water holds so much "alkali" in solution as to be unfit for purposes of irrigation.

The land from which the water has receded, although rich in potash and phosphoric acid, and possessing a full supply of lime and humus, contains sufficient "alkali" to interfere seriously with agriculture. The most deleterious salt present is sodium carbonate, which constitutes more than 10 per cent of the "alkali." It is the opinion of agricultural chemists, however, that upon the addition of from 100 to 200 pounds of gypsum to the acre, and when the soil has been sufficiently aerated by cultivation, the land formerly covered by Lake Tulare will be one of the most fertile portions of the San Joaquin Valley. Moreover, these lands are naturally adapted for irrigation, on account of the smoothness of their surface and the uniformity of their slope.

The lands bordering on Lake Tulare, especially on its eastern side, are not only situated at elevations which might be commanded by irrigating ditches, but, as a perusal of the following pages will show, there is a supply of subterranean water, which could be used for purposes of irrigation.

So far as borings have shown, the artesian area on the east side of the valley extends to a superficial elevation of about 300 feet. The wells that have been bored to the eastward of the Southern Pacific Railroad are few in number, and comparatively shallow; it is very desirable that deeper experimental wells should be bored farther toward the eastern foothills. One thing is certain, that at Alila, which is close to the line marking an altitude of 300 feet on the irrigation map, a strong flowing well was obtained, as hereinafter noted. This line, marking an altitude of 300 feet, meanders in a northeasterly direction from Alila, and approaches to within 2½ miles to the westward of Belleville, and to within something less than 2 miles of Woodville; it passes about 2 miles to the eastward of Tulare and 3 miles to the eastward of Goshen; it then meanders toward the foothills, to a point about 5 miles eastwar

from Grand View, whence it bends westward to within half a mile of Kingsburg, on the northern boundary of the county.

On the eastern side of Kern and Tulare Counties, between the altitude of 400 and 500 feet, no doubt a great deal of water sinks in the micaceous sands, which have been formed from the disintegrated granitic rocks of the Sierras and from the loose Tertiary formations of the foothills. It is therefore quite possible that the eastern limit of the artesian area in valley lands of Tulare lies farther to the eastward than has been heretofore supposed, especially in the northeastern portion of the county. Irrigation in the upper portion of the San Joaquin Valley will no doubt more and more affect the subterranean hydrography of adjacent and less elevated districts.

At five or six places within short distances from the Southern Pacific Railroad in Tulare County and at Alila, flowing water has been struck between the depths of 400 and 500 feet, and a strong flow of water was obtained at the latter place between the depths of 1,000 and 1,328 feet.

Toward the lake, the depth at which the first flowing water can be obtained is frequently more than 500 feet, but well-borers state that the flow of water from the deeper wells near the eastern margin of the lake is very strong. There appears to be a particularly strong flow in some wells here recorded, which were bored a few miles west of Pixley. It is not improbable that gas, as well as hydrostatic pressure, may have something to do with the phenomenon.

On the western side of the county experiment has proved that flowing wells can be obtained as far west as a line drawn north and south through Tulare County, cutting what at the time of the last survey was the western bank of the lake. Data with regard to wells in the western portion of the artesian area in this county are somewhat meager, but from what had been gathered up to the time of this writing, it appears that flowing water in the western portion of the valley lands is much more uncertain; the flow is weaker and the water not so good.

The writer did not obtain any analyses of artesian waters in Tulare County. It is quite desirable that such should be made in order to determine their value for irrigation. Inflammable gas was struck in several borings in Tulare County, the greatest volume and pressure being in the vicinity of the lake.

It appears, from shells brought up during the process of boring the Lambertson well, as hereinafter mentioned, that the filling of the valley to a depth of more than 1,000 feet is of very recent date. Throughout the eastern portion of the valley lands of Tulare County, a good supply of water is obtained from shallow wells, which seldom exceed 50 feet in depth, and frequently from those much less. The western valley lands are not so well favored, and throughout the territory skirting the foothills of the Coast Range the subterranean supplies of drinking water are very uncertain.

In the eastern mountains of Tulare, several new mineral discoveries have been made, and some mines have been worked. Prospectors report that it is not lack of valuable mineral that has retarded mining interests in Tulare County, but the difficulty of enlisting California capital in enterprises so close at home.

The grand scenery in many parts of Tulare County must eventually attract tourists to this portion of California. During 1891, trails were made in the Sequoia Park, where the troops were stationed during the

summer, and before another year has passed this picturesque district will be much more accessible.

In the southeastern portions of the county there are several hot springs, which are said to work wonders in cure of rheumatic complaints.

In 1891 a meteorite is said to have fallen a few miles southwest of Visalia. It is to be hoped that if the meteorite, or any pieces of it, are found, the finders will inform the California State Mining Bureau of their discovery. A number of Indian relics have been brought to light by the receding waters of Lake Tulare.

FLOWING WELLS.

The following wells have been taken as typical examples, and will give the reader some idea of the depth at which flowing water may be obtained by boring, and the character of the strata penetrated:

In August, 1885, a well was bored to the depth of 730 feet, on the ranch of P. P. Martin, about 7 miles west of the town of Tulare. The formation was found to be alternate strata of sand and clay. The first flow was struck at a depth of 395 feet; sixteen different flows of water were observed, the strongest being at a depth of 500 feet. This well flows 4½ inches over an 8-inch casing.

On the Paige & Morton ranch, about 3 miles west of the town of Tulare, a well was bored to a depth of 330 feet, which flowed 3½ inches over a 7-inch casing.

Near Pixley, which is about 17 miles south of Tulare, a well was bored on the ranch of L. L. Tinkham, to a depth of 713 feet, through alternate strata of sand and clay. Flowing water was struck between the depths of 345 and 359 feet. Eleven different flows of water were observed in this well, from which the water flowed 3½ inches above a 9-inch casing.

About 2 miles east from Pixley a well was bored several years ago, on the Priest ranch, to the depth of 600 feet, from which the water flowed three quarters of an inch above an 8-inch casing.

From a well 955 feet deep on the ranch of C. S. Peck, about 1½ miles northwest from Pixley, the water flowed 2 inches above a 9-inch casing. In this well many of the strata below a depth of 500 feet were as hard as sandstone, and they were interstratified with clay.

On the ranch of D. C. Allen, about 3 miles west of Pixley, a well 858 feet deep flowed 8 inches above an 8-inch casing. In this vicinity a well on the Towne ranch 809 feet in depth flows 6 inches over an 8-inch casing.

On the ranch of J. Iton, about 3 miles southwest from Pixley, a well was bored in January, 1891, to a depth of 815 feet. The first flow of water occurred between the depths of 400 and 404 feet. There were fourteen different flows of water in this well, and when it was completed the water flowed 2½ inches over a 9-inch casing.

A well was bored to a depth of 1,150 feet in the spring of 1892, on the ranch of B. G. Lathrop, Jr., in Sec. 16, T. 23 S., R. 24 E., M. D. M., about 6 miles southwest from Pixley. Flowing water was obtained in nearly every thick stratum of sand below a depth of 300 feet. The water from this well flowed 11 inches over a 9-inch casing. The formation penetrated consisted of strata of sand, gravel, and clay. During the process of boring this well the sand pump brought up a horse's

tooth from a depth of 1,050 feet. The tooth was imbedded in a fine sandy conglomerate, the cementing material of which was calcareous.

A flowing well was also obtained on the ranch of J. Black, about 6 miles west of Pixley. The well is 950 feet deep, and flows 8 inches above an 8-inch casing. Flowing water was struck at a depth of 537 feet.

In 1891 a well was bored to a depth of 895 feet 10 miles southwest from Pixley, on the ranch of W. B. Bradbury. Flowing water was struck at a depth of 450 feet. The water from this well flowed 4 inches over a 10-inch casing. Much white clay was passed through in this well, and some shells were brought up by the sand pump.

In April, 1891, a well was bored to the depth of 937 feet on the ranch of S. H. Overacker, in Sec. 10, T. 23 S., R. 24 E., M. D. M. At a depth of 585 feet the water flowed half an inch over the 9-inch casing. Nineteen different flows were tapped, and at the completion of the well the water flowed 2½ inches above the casing.

At Alila a well was bored, about two years ago, to the depth of 1,328 feet, and the water flowed 3 inches above the casing. The formation penetrated is sand and clay. In this well the first flowing water was struck at a depth of 300 feet, from which depth the water flowed half an inch above the casing. The greater part of the flowing water, however, came from below a depth of 1,000 feet. A small quantity of gas was observed in this well.

At Sevilla Colony, 16 miles southwest from Pixley, a well on the Cline ranch yields a sulphuretted water, which flows about 1 inch above an 8-inch casing. From this well a large amount of gas is also discharged, which burns with a clear flame. This gas, which is said to flow at the rate of several thousand feet a day, has been running to waste for more than five years. This well is about 600 feet deep.

At the Lambertson ranch, in Sec. 12, T. 22 S., R. 22 E., M. D. M., a well was bored to a depth of 1,058 feet in April, 1889. The first flowing water was observed between the depths of 648 and 663 feet. The formation was alternate strata of sand and clay, with much quicksand. The flows of water from this well seemed to come from the finest sand; the last 200 feet or more was nearly all through fine sand. This stratum contained numerous shells and fish vertebræ. The water from this well flowed 7½ inches over the casing. Inflammable gas was struck at a depth of between 600 and 700 feet, and seemed to accompany the water.

The organic remains brought up from this well were submitted to Dr. J. G. Cooper, who determined them as follows: *Aenonicola*, n. s. sp., fresh water shell (Quat.); *Sphærium dentalium*, fresh water shell (living); fish vertebræ, and a piece of shell indeterminable.

In July, 1889, a well was bored to a depth of 887 feet on the E. Jacobs ranch, about 7 miles north of the Lambertson well; flowing water was struck between the depths of 508 and 514 feet. The formation was similar to that at the Lambertson ranch, but contained less quicksand. Fifteen different flows of water were observed. The water flowed 4½ inches over a 9-inch casing. At a depth of 190 feet a flow of gas was encountered, which blew the water out of the casing. The gas appeared to come from a stratum of loose sand about 1 foot in thickness, which was overlaid by a stratum of blue clay about 50 feet thick. Gas was found with every subsequent flow of water. The water

was fresh, but tasted slightly of sulphur, as does nearly all the artesian well water in this part of the country.

A second well was bored on the Jacobs ranch, farther west than the first well, and about 2 miles from what was at that time the eastern margin of Tulare Lake. This well was bored to the depth of 835 feet. The formation was similar to the first well. Twelve flows of water were struck, and at the completion of the well the water flowed 3 inches over a 9-inch casing. This well is about 6 miles west of the survey line of the shore of Lake Tulare made in 1880.

In February, 1890, a third well was bored on the Jacobs ranch, about 25 miles west of the town of Tulare, and south of Lemoore. This well is distant about half a mile from what was then the northeast shore of Lake Tulare, and it is 498 feet deep. The formation is sand and clay, with much quicksand. Seven flows of water were obtained, and at the completion of the well the water flowed about 1 inch over a 9-inch casing. The first flow of water was struck at a depth of 233 feet. Gas was observed accompanying the water from all the deeper strata of sand.

In April, 1890, a fourth well was bored on the Jacobs ranch, about 2 miles north and a little east of the third well. The water from this well flowed about 1¼ inches over a 9-inch casing. Flowing water was struck at a depth of 299 feet. Gas was observed accompanying the water from all the deeper strata of sand. This well is 539 feet deep.

The town of Hanford is supplied by an 8-inch artesian well 560 feet in depth. The formation penetrated is alternate strata of sand and clay; no flowing water was observed until a depth of 560 feet was reached. Continued pumping, with a pump throwing 25,000 gallons of water per hour, lowers the water to a depth of from 15 to 20 feet. The water, when first pumped, has a slightly sulphuretted odor and taste. From this well the town of Hanford is supplied with about 150,000 gallons of water daily during the summer, and about 50,000 gallons during the winter. There is also an artesian well, said to be 1,300 feet deep, at the Artesia Hotel, in Hanford.

On the Flaxman ranch, about 14 miles south of Hanford, close to Tulare Lake, flowing water was obtained at a depth of 78 feet. Numerous fragments of "mussel shells" were observed in the strata penetrated by this well, and gas accompanied the flowing water; when the gas was ignited the flame rose 4 inches above a 5-inch casing.

On the western shore of Lake Tulare, a flowing well is reported as being only 110 feet deep. There is also a flowing well at Lemoore, but the water is saline and sulphuretted.

SHALLOW WELLS.

The town of Visalia is supplied by the waterworks owned by Crowley Bros., who derive their supply from four wells near the center of Visalia. These wells range from 50 to 90 feet in depth; their respective diameters are 7, 8, 10, and 12 inches. The principal water-bearing stratum appears to be at a depth of from 35 to 40 feet, at which depth a clean gravel yields an abundant supply. The water usually stands at a depth of 6 or 7 feet from the surface, but continued pumping at the rate of 40,000 gallons an hour lowers the water to a depth of 27 feet. By way of experiment, water was pumped from the 12-inch well belonging

the waterworks, at the rate of 75,000 gallons an hour, which lowered the water to a depth of 29 feet.

The formation penetrated at the Visalia Waterworks was noted as follows:

Sediment loam	8 feet.
Surface water.	
Clean sand	10 to 20 feet.
Yellow clay	2 to 4 feet.
Coarse sand and gravel, with plenty of water	40 feet.
Yellow clay	¼ foot.
Sand, with water	10 feet.
Yellow clay.	

In summer about 40,000 gallons of water an hour is pumped from the wells of the waterworks, and in winter probably half that amount.

Within a distance of about 10 miles from Visalia a good supply of water can be obtained at depths varying from 35 to 80 feet. The formation is about as follows:

Soil, sandy loam	8 to 10 feet.
Surface water; very hard.	
Yellow clay	3 to 40 feet.
Sand and gravel, with good water	4 to 20 feet.
The water from this gravel rises to within 8 or 10 feet of the surface.	
Red or yellow clay	3 to 40 feet.
Sand, or gravel, with more water.	

From an 8-inch well, penetrating this last stratum, a 6-inch stream may be continuously pumped without materially affecting the supply.

Northward from Visalia there is much clay and hardpan, but plenty of good water can be obtained at a depth of from 40 to 60 feet. Eastward from Visalia the water supply is more irregular, the best water-bearing strata corresponding to the ancient river channels. As the hills are approached the water lies deeper and much hardpan is encountered; still, water can be obtained at the edge of the foothills at a depth of from 70 to 100 feet, and at a short distance therefrom at a less depth.

Toward Tule River, eastward from Woodville, the formation is principally sand and gravel to a depth of from 35 to 40 feet, beneath which cobblestones and bowlders are struck, with a very strong head of water, which rises to within 10 to 12 feet of the surface of the ground. Westward from Woodville the formation resembles that around Visalia, but it is more clayey.

The town of Tulare is supplied with water by the Tulare Water Company, and by numerous private wells. The Water Company obtain water from five wells: One 9-inch well, 552 feet deep; one 9-inch well, 396 feet deep; one 8-inch well, 394 feet deep; one 8-inch well, 390 feet deep; and one well which is still deeper. These wells are all bored within a radius of 100 feet. The formation penetrated is sand and clay. The water rises to within 15 feet of the surface during the dry season, and to within 10 feet during wet periods of the year. During the summer about 30,000 gallons an hour is pumped from these wells. Continuous pumping at this rate lowers the water about 2 feet.

Around Tulare the superficial strata are as follows:

Sandy loam	2 to 4 feet.
Yellow clay	2 to 7 feet.
Sand and quicksand	1 to 20 feet.
The surface water is struck in this sand at a depth of from	10 to 15 feet.
Yellow, blue, red, and sometimes white clay, interstratified with sand	30 to 90 feet
All the sandy strata contain an abundant supply of water.	

In the vicinity of Pixley the surface water is struck at a depth of from 18 to 25 feet. The formation by boring is:

Sandy loam	18 to 25 feet.
Surface water.	
Clay	2 to 10 feet.
Coarse sand and gravel, with plenty of good water	5 to 25 feet.

Eastward from Pixley and Alila the depth of the wells increases, and at a distance of 10 miles east of Alila wells are frequently 200 feet in depth. Westward from Pixley the water flow approaches the surface, and toward the margin of the lake water is struck at a depth of a few feet.

In boring shallow wells around Hanford, the following formation has been observed:

Surface soil, varying from clayey to sandy loam	6 to 10 feet.
Surface water, but very hard.	
Alternate strata of sand and clay	20 to 100 feet.

There is an abundant supply of good water in the sandy strata at depths varying from 30 to 100 feet.

On the western side of the valley the water supply becomes very uncertain as the ground rises toward the foothills; indeed, at one place, about 20 miles west of the center of the valley, a well was bored to the depth of 300 feet without the formation exhibiting any signs of moisture.

GOLD AND SILVER.

The Barton Mine.—This mine, which is about 25 miles northeast from Visalia, is situated in Sec. 21, T. 15 S., R. 26 E., M. D. M. Work was actively prosecuted at this mine during 1891–92, the ore being worked in a 3½-foot Huntington mill, with Challenge feeder, driven by steam. The workings at this mine consist of an upper and a lower tunnel. The upper tunnel is about 170 feet long, and has been run on the course of the vein, which averages from 4 to 10 feet in width. The lower tunnel has been run about 250 feet in length; it has been driven all the way in ore. At the time of this writing work was being carried on in the upper tunnel, where the ore is softer than in the lower workings. The ore is conveyed by flume a distance of 300 feet to the mill. Messrs. Barton state that they are now taking steps to save their concentrates and are building shaking concentrators, patterned after descriptions and designs given in the State Mining Bureau Report of 1890. It is said that the vein on which the Barton Mine is situated has been traced for a distance of 3 miles.

Globe District.—Several new discoveries are reported in this district, and samples from new ledges discovered upon the White Chief claim are said to have assayed from $4 to $137 a ton. The Globe District is situated on the Middle Tule River, about 12 miles east of Porterville.

White River and Mineral King Mining Districts.—Several new discoveries are reported in these districts, and mining is said to have been carried on there during 1891–92. Lack of time prevented the writer visiting these districts before going to press. The work carried on in the Mineral King Mining District during 1891–92 is said to have been principally in the nature of prospecting and assessment work.

IRON ORE.

A large deposit of bog-iron ore is reported on the Middle Fork of Tule River.

CHRYSOPHRASE.

A new ledge of chrysophrase has been discovered about 12 miles northeast from Visalia; it is of inferior quality, but its existence encourages further prospecting for that mineral in the eastern mountains of Tulare County.

MAGNESITE.

A large deposit of magnesite has been discovered near Mineral King Mining District, about 50 miles northeast of Visalia.

TUOLUMNE COUNTY.

By E. B. Preston, E.M., Assistant in the Field.

The nearest and best route to reach the county seat, Sonora, which is the central point for the mines of this county, is by way of Stockton, the head of river navigation, thence by a branch railroad to Milton, in Calaveras County; from there a stage line conveys passengers and freight over 42 miles of good mountain roads.

The county is entered at Lavillas Ferry, a crossing of the Stanislaus River, where the formation consists of slates, while a short distance south a belt of serpentine commences that stretches down along the Mother Lode. The first mine passed on the road is the Carrington, a patented claim, not working, after passing which a strip of dioritic rock is crossed. A mile beyond another patented mine, the Patterson, is also idle. To the east, toward Tuttletown, several pocket mines are being worked in a small way. The road flanks Table Mountain, a lava flow that circles down from the northeast, a conspicuous feature for many miles. The gravel channel beneath has formerly been extensively worked.

After crossing the lava belt near the Jefferson and San Juan Gravel Mines, the road crosses a large limestone belt that enters the county a few miles north and extends through Shaw's Flat to Sonora, where it is about one half mile across. To the southeast of the limestone belt the metamorphic slates crop out, in which, around the neighborhood of Sonora, quite a number of small pocket mines are being worked. The following useful mineral products and rocks are found in the county: Gold, silver, copper, lead, tin, iron, chrome, molybdenum, zinc, manganese, tellurium, bismuth, uranium, marble, lime, and granites.

In looking over the county generally for the location of its mining resources, we find first, on the west side of the Mother Lode, in the metamorphic slates, a copper mineral belt passing through the county with the general trend of the auriferous slate belt. From its favorable location as regards water and timber, and the fact that it is situated in a climate where operations can be carried on cheaply the year around, as well as the facilities of transportation that can be brought within easy reach, it deserves closer investigation by those operating in this metal. Adjoining and paralleling this belt on the east is the main belt of the Mother Lode, entering from the south at Moccasin Creek, and leaving at the northeast corner of the county at Robinson's Ferry. Again, 10 miles east, and nearly parallel, is the Eureka, or main fissure belt; yet farther east is a series of veins a few miles from Cherokee that might be designated as the contact belt of the veins. Still rising up the mountain flank we have some veins in granite, and in the high Sierra the mines constituting the Tioga mineral district.

South of the Tuolumne River, in the neighborhood of Groveland, the following mines have been at work during the past season:

THE MARY ELLEN MINE

Is situated 15 miles southeast of Sonora, on the North Fork of the Tuolumne; a patented claim, with a millsite near the river. It has been opened by three tunnels, of which the first is 350 feet long, No. 2, 275 feet, and No. 3, 300 feet. These tunnels are 150 feet apart, giving a perpendicular depth below the surface of 450 feet. They cost $46 a foot to run, including rails, air pipes, etc. The company has built a good 3-mile road. The mill, which burned down in October, contained ten stamps of 750 pounds, driven by steam, and an 80-foot canvas concentrating plant. The vein strikes east and west, dipping north 60°, with slate walls from 3 to 5 feet apart. The ore is said to average $12 per ton in free gold, and to contain 4 per cent of sulphurets, consisting of galena, zinc, antimony, iron, and copper. Twenty-five per cent of the returns from the sulphurets is silver. Three pay shoots are known to exist, pitching to the east at an angle of 45°. No. 1 is 80 feet, No. 2 is 50 feet, No. 3, just opened; 60 feet in length has been stoped on the vein. From twelve to forty men are employed. In connection with this, three extensions are being prospected, known as the Mascot, San Carlos, and Preciosa.

THE MASCOT

Is a contact between lime and slate, but of the same strike as the Mary Ellen; the vein averages 18 inches. It has a shaft and tunnel, the former 60 feet perpendicular, at which depth the tunnel, which is at present 50 feet long, will connect with the shaft; a pay shoot 60 feet long has been found on the surface. The tunnel can be driven for $3 a foot.

COSMOPOLITE, LONGFELLOW, AND LUMSDEN MINES.

All these are situated on the south side of the Tuolumne River, near Groveland and Big Oak Flat. Nothing but pumping and assessment work is being done there at present. The Lumsden is running a drain tunnel. The Longfellow will be started up when pumped out.

THE BUCHANAN MINE.

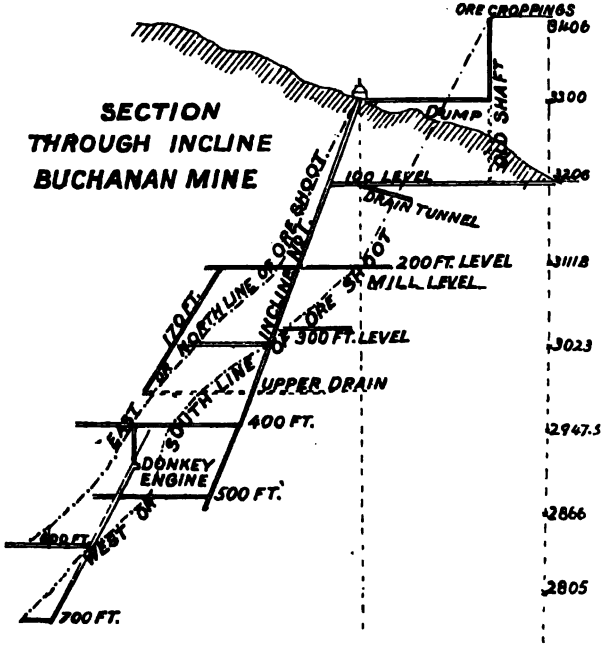
To the north of the Mary Ellen is one of the best equipped mines in Tuolumne County. It is known as the Buchanan Mine, and is situated in Secs. 26 and 27, T. 1 N., R. 16 E., M. D. M., between the Middle Fork and the main Tuolumne River, 28 miles from Sonora, to the east of what has been designated as the main fissure vein, to which it seems to be a feeder.

The general strike is northeast, dipping to the south at about 45°, with an average of 20 feet between the walls, which are slate. Three bodies of quartz, separated by black slate, are known; next to the wall is a very pronounced gouge from 2 inches to 2 feet in width. During the past thirty months the quartz next to the foot wall has furnished most of the ore that has been reduced, yielding about $5 per ton in free gold and about 1½ per cent of sulphurets, averaging about $60 per ton, consisting mainly of iron and galena sulphides.

Accidentally, through a cave-in, the quartz body next to the hanging wall that had received but little attention, was uncovered, a crushing

of several hundred tons proving it to be of far greater value than the foot wall ore body, both as to free gold and also in the yield of the sulphurets, carrying $15 in free gold and $200 in sulphurets. Work is being directed toward its development. The sinking of the lower shaft at present is developing some very fine ore. The vein matter is ribbon quartz with a gouge almost like plumbago; layers of black slate are found between the quartz ribbons.

The claim contains 3,000 feet of the vein, with three known ore shoots; one of 200 feet in length, the second about 50 feet, and the extent of the third has not yet been determined. These shoots pitch to the northeast. The mine is operated through two shafts (5 by 9 feet) and a tunnel; the upper shaft has attained a depth of 800 feet, the lower 380 feet, perpendicular; both are on an incline. The tunnel, which is 380 feet in length, cuts the vein at 175 feet and is continued through; where it cuts the vein a vertical depth of 100 feet is attained.



The tunnel was advanced at the rate of 3 feet a day with two shifts, costing about $7 per foot. The sinking of the shaft amounts to 1 foot per day, at a cost of $25 per foot. Both shafts and tunnel are thoroughly timbered with pine, which is obtained on the ground at a cost of $15 per thousand feet. The works have their own sawmill.

The ores, when hoisted, are conveyed on a tramway and incline to the mill direct; the incline has a length of 500 feet. The reduction works consist of a twenty-stamp mill with 850-pound stamps, supplied with chrome-steel shoes and dies, Blake crusher No. 2, and Hendy self-feeders, and eight Frue vanners. The stamps drop ninety strokes a minute on a 6-inch drop, and have a capacity of 1½ tons per stamp. Two

batteries are furnished with slot-punched screens and two with wire. Of amalgamated copper plates there are on the inside of each battery one, 4 feet by 6 inches, a 4-foot by 10-foot apron in front of each, and 14 feet of sluice plates 20 inches wide. One third of the free gold is caught in the battery and two thirds on the plates. The concentrations from the eight Frue vanners are chlorinated in the company's works on the ground. The roasting is done in a common reverberatory furnace, with a 3-ton per day capacity, consuming one fourth of a cord of wood per ton, costing $4 per cord; the cost for chlorination is given at $14 per ton, and the yield 90 per cent of the assay value.

At the upper shaft the pump works two hours per day, hoisting a 3-inch column of water, and at the lower shaft it works continuously, hoisting 2 miner's inches. The pumps consist of a Worthington and a duplex.

The power used is steam. There are in all five engines, running two hoisting works, a sawmill, a twenty-stamp quartz mill, consuming for steam seven cords, and for drying and roasting the ore three fourths of a cord of pine wood, costing $4 per cord. Twenty-four men are employed, sixteen in the mine, two in the mill, and six on the outside; of these, the miners receive $3 per day, the mill men $3 50, and the outside men $2. Belonging to the works are substantial blacksmith and carpenter shops, boarding houses, and stables.

A good graded mountain road has been built by the company a distance of 11 miles at a cost of $10,000, also 4¾ miles of ditch and flume, the water being taken out of Hunter's Creek.

THE CHAPARRAL MINE,

West of the Buchanan Mine, on the opposite side of the ridge, facing the Tuolumne River, in the mineral slate belt, is a patented claim of 1,500 feet by 600 feet. The croppings spread out over 150 feet of the surface, with bodies of slate between the quartz. The strike of the vein is north 40° west, with a dip of 40° to the east, and a distinct black clay gouge on the foot wall. The ore is a ribbon quartz and carries sulphurets.

The developments consist of a 40-foot shaft and several tunnels. Tunnel No. 1, at an altitude of 2,820 feet above sea-level, starts below the croppings and connects with a stope that comes up from tunnel No. 2, 50 feet below. In No. 2 tunnel, which, with its branches, is 600 feet long, a winze has been sunk immediately below the upraise that connects it with No. 1. At a depth of 25 feet the ore body on which it was sunk dips out of the winze. No. 3 tunnel, started 60 feet below No. 2, has been run a distance of 350 feet; in it the vein matter is slate filled with seams of quartz, and the foot wall slate is highly mineralized.

Three hundred tons of ore from this mine was worked in a small water-power mill, situated on the opposite bank of the river, and yielded $20 per ton in free gold. Work is to be resumed shortly on this claim, which is favorably located for opening by tunnel and the use of electrical or water power.

Continuing along the course of this belt in a northeasterly direction, a number of idle claims in the slate are passed, whose present owners are not in a position to put up works of sufficient magnitude to work the low-grade ores profitably.

The next active mine in this direction met with is

THE NEW ALBANY MINE,

Situated on the banks of the North Fork of Tuolumne River, on the contact of the granite with the slate, at an elevation of 2,250 feet above sea-level, holding three claims 1,260 feet in length on the vein by 600 feet wide. This is in the old Soulsbyville Mining District, and about 11 miles southeast of Sonora. The vein courses northwest and dips to the east at an angle of 60°, and is an east feeder on the main Eureka belt. It varies in width from 2 to 20 feet, and carries a granite hanging and a slate foot wall. It is opened by shaft and tunnels. The ore shoots are being worked, one 200 feet in length, the other for a distance of 120 feet. These shoots pitch to the south. The incline shaft is 800 feet in depth, and has five levels running from it to the south, two of which have been filled up; of the remaining three, the first extends 200 feet, the second 150 feet, and third 200 feet. The shaft is 6 feet by 10 feet in the clear, and was sunk through slate and quartz at the rate of about 1 foot per shift. The quartz is free-milling, carrying about one half per cent of iron sulphurets and galena. The granitic rock is extremely hard, and the walls stand so well that no timbering to speak of is required. At a depth of 85 feet a drain tunnel taps the shaft. From the mine the ore is conveyed by an inclined tramway about 340 feet long, with a fall of 200 feet, to the mill, which consists of ten stamps of 750 pounds weight, a Brodie crusher, Hendy self-feeders, and a canvas plant, all run by water power, applied to two Dodd wheels—a 3-foot wheel for the stamps and a 1½-foot wheel for the rock-breaker. These Dodd wheels are said to give 15 per cent more effective force than the Pelton.

The stamps, crushing 2 tons per stamp in twenty-four hours, drop 6 inches one hundred and six times a minute, with a 6-inch discharge. Tinned sheet-iron screens with round-punched holes (No. 40) are used; they are very cheap, and from their flexibility are said to prevent the baking of the pulp next the screen; of course their term of usefulness is short, rarely lasting over one week, and sometimes not over one day; the price is about 10 cents a foot. Cast-iron shoes are used on steel dies, a set lasting about three months. Two plates are used inside the battery, the back plate 6 inches wide, the front 4½ inches. Below the battery is a silver-plated apron 5 feet long and 4 feet wide, from which the pulp passes over 7 feet of sluices, 4 feet wide, onto a 50-foot canvas plant. These latter are coming into general use, and are of great value in diminishing the inevitable loss attending the beneficiating of ores by battery amalgamation, especially where the ores carry an appreciable amount of sulphurets, and sufficient water can be obtained without too great a cost. The yield shows a saving of two thirds in the battery against one third on the plates; the concentrates are valued at about $40 per ton, but have not been treated up to date.

The power is applied under a 320-foot pressure for the mill, and 300 feet for the rock-breaker, through a ¾-inch nozzle. The Tuolumne ditch furnishes the water. The company have flumed and ditched for 3 miles, at an outlay of $6,000. A crew of eleven men is employed—three in the mine, two in the mill, and six on the outside.

Adjoining to the southwest is the

POOR MAN'S FRIEND MINE,

On the same vein, only here it is split up. One of the seams being worked strikes 20° west of north, and dips to the east at an angle of 55°. Three tunnels have been run, measuring 100 feet, 60 feet, and 20 feet. in which the vein has an average width of 1 foot. Only assessment work is being done.

To the south, on the opposite side of the river, is

THE LADY WASHINGTON MINE,

Situated on the Eureka vein, showing two parallel bodies of quartz. The east vein is 7 feet, the west 4 feet in width; they are cut by two tunnels 300 feet apart, the upper one 500 feet and the lower 700 feet long, connected by stopes; from the level of the lower tunnel a shaft is sunk on the 4-foot vein to a depth of 400 feet. A deeper tunnel is in contemplation.

CONSOLIDATED EUREKA AND DEAD HORSE MINES.

Under one management, adjoining each other; the latter alone is being worked at present. During the past two years the main shaft has been sunk 200 feet to the 1100-foot level, and a drift run north from the shaft 200 feet. The ledge varies from 1 to 5 feet. The drift will be carried on another 100 feet to reach the main pay. The mill has been running continuously on ore taken from between the 700 and 900-foot levels, which ground has been stoped a length of 100 feet. The ore carries about one quarter of one per cent of sulphurets. The concentrates are shipped by wagon to the chlorination works at Angels Camp, Calaveras County, at a cost of $8 per ton. The twenty-stamp mill runs eighty-nine drops per minute. They employ no apron plates in this mill. The pulp from the battery runs over a board onto the sluice plates, which are 20 feet in length and 16 inches wide. These discharge upon Frue vanners, two for each battery, supplied with amalgamated plates. Only one third of the amalgam is retained in the battery. The motive power is water taken from the Tuolumne Ditch and Water Company. Ninety-five inches is used, 25 inches of which goes to furnish power to the mill, applied to a 6-foot Donnelly wheel and a 3-foot Knight wheel for the largest size Blake crusher. The air compressor is run by a 6-foot Donnelly and the hoisting works by a 6-foot Pelton wheel.

Crossing Turnback Creek, on the strike of the lode in the granite formation, is a cluster of mines on the main vein and its lateral feeders, which come in both from the east and west, the ore in the latter surpassing that of the former in the quantity and quality of sulphurets, as also in the yield of free gold. The first are

THE LAURA AND NORTH STAR MINES,

Adjoining claims on the main Eureka vein. They are connected by a tramway 1,000 feet long leading to a ten-stamp mill, equipped with self-feeder, rock-breaker, and two Hendy concentrators. Shafts have been

sunk on both properties, that on the North Star having been lately retimbered for 100 feet; a donkey engine supplies the power for hoisting. The vein is said to show strong in the shaft from 4 to 5 feet thick, carrying about $4 per ton in free gold and an appreciable amount of sulphurets. The Laura has a 200-foot shaft, the lower part of which is caved in. The North Star shaft, partly filled with water, is to be pumped out and sunk deeper.

To the southwest, in the immediate neighborhood of the last mentioned mine, is

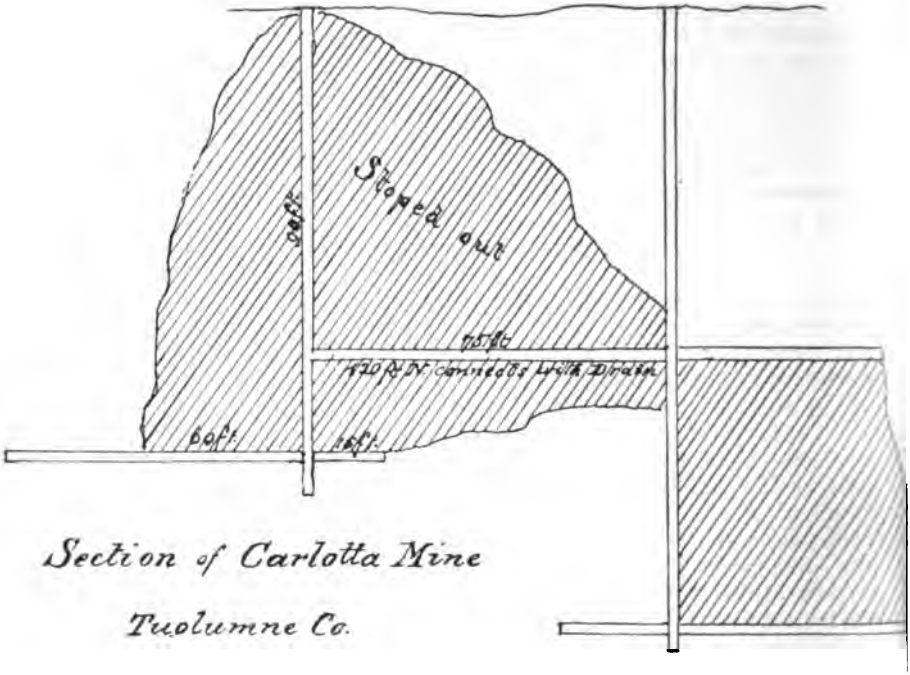
THE PORTO FINO MINE.

It is a west feeder to the main Eureka vein, coursing north 40° east, with granite walls and a clay gouge, the vein showing a width of from 8 to 16 inches, carrying a ribbon quartz with 5 per cent of sulphurets, chiefly iron, galena, and zinc sulphides. A shaft 3 by 5 feet has been started on the vein, which is down to a depth of 100 feet, and a contract for another 100 feet has been let. A drift has been started on the vein about 50 feet from the surface to the northeast, which shows improvement as it progresses. A thrashing engine is being temporarily used for hoisting and pumping purposes; a Hooker pump, with an 8-inch stroke, runs part of the time only. Ventilation is supplied through a fan. Near the surface the ore paid $25 in free gold; a run made from ore near the bottom of the shaft yielded $42 in free gold, while the sulphurets showed a value of $130 per ton. About 400 feet to the east on this claim is another vein approaching the other on the north. The ore has to be crushed in a custom mill at present, but as soon as the value of the mine is definitely established the owners will erect a mill of their own.

THE CARLOTTA MINE

Is in the immediate neighborhood of the preceding claims, its ground abutting onto both the Laura and North Star at almost right angles. The vein courses a little north of east, dipping at an angle of 75° to the northwest; a cross course striking northwest throws the Carlotta slightly out of its direction. There is a very imperfect separation between the granite walls and the vein, the latter in places being frozen to the granite, and only a slight gouge anywhere.

During the past two years the Carlotta has been reopened with an inclined shaft 4 by 8 feet in the clear, sunk on the vein to a depth of 140 feet, at a cost of $22 50 per foot, showing an 18-inch vein. Drifts from the shafts have developed two ore shoots, in one of which stoping has been done; the ore, crushed in a mill 5 miles away, gave very satisfactory results. The quartz carries a large percentage of sulphurets of iron, lead, and zinc of good value with the free gold. The mine makes about 400 gallons of water in twenty-four hours, which is hoisted out with a Baker horse whim, using iron buckets and a 1-inch hemp rope. Six men are employed at present. The cost of hauling and milling amounts to $4 75 per ton, which will be greatly reduced when the company erects its own mill, which can be run by water power without great expense.



Section of Carlotta Mine

Tuolumne Co.

THE PENNSYLVANIA MINE,

Belonging to the same company as the Carlotta, corners on the west with their ground. The vein, which is narrow, dips toward the Carlotta. The outcrop of the vein was worked by an open cut for a distance of 750 feet on a continuous ore shoot. A shaft was sunk on the vein to a depth of 75 feet, showing in the bottom a 15-inch vein of good pay ore. The company is merely keeping up its assessment work on this portion of its property.

Just beyond this group of mines, near the village of Cherokee, the course of the Eureka lode is crossed by a lava flow covering a part of an old channel. Some drift mines have been worked here, but nothing of importance in that direction is in active operation at present.

On the west side of the lava and also to the west of the Eureka lode, and about 6 miles due east of Sonora, is a group of mines. The only one that has been in operation during the past year is

THE BLACK OAK MINE.

Since it was previously reported on the shaft has been extended down another 100 feet, and drifts run both north and south 100 feet and 150 feet; the sinking of the shaft cost $30 a foot. The vein is from 5 to 6 feet wide, ribbon quartz, containing 4 per cent of sulphurets. The mine makes about 6 miner's inches of water, which is handled by three 6-inch pumps. The country rock is granite, with slate casing and black slate gouge.

The ten stamps of the mill are supplied with three-keyed tappets to add additional weight to the stamps (900 pounds), on account of the hardness of the quartz. They have plates in the mortar, both back and front, using No. 50 screens, and getting a duty of 2 tons to the stamp; they claim a saving of 70 per cent of the amalgam in the battery. After passing from the battery the pulp discharges into a sluice in front of the screen, supplied with four spouts discharging onto 30 feet of silvered plates, which carry the material to six Frue vanners; from these it is led over four separate canvas plants, 16 feet by 24 feet. A 4½-foot Dodd Sismoidal wheel has been introduced for the motive power at the mills. The ore is obtained from a shoot 190 feet long, dipping to the north. Other shoots showing on the surface are not developed. The extreme hardness of the rock makes the working of the mine expensive; machine drills should be used here throughout. Twenty-five men are employed; twenty in the mine.

THE LIVE OAK MINE

Is the southern extension of the Black Oak, and has a shaft 80 feet in depth sunk on the vein, supplied with engine and boiler and a 4-inch jack-head pump. Water has at present shut the mine down. The vein, which is stated to carry rich ore, shows a width of 3 feet.

Returning to the course of the Eureka vein, at Sullivan's Creek we find considerable work being done on a vein holding the same strike and dip, formerly known as the Hyde Mine, now known as the Belleview.

THE BELLEVIEW MINING AND AGRICULTURAL COMPANY.

The company owns under patent from the United States 640 acres of land in Secs. 13, 23, and 24, T. 2 W., R. 15 E., containing numerous veins of auriferous quartz. One of these has been developed, the company confining themselves to the working of this alone.

The work comprises an inclined shaft 10 feet by 6 feet, sunk on the vein 435 feet, with four main working levels driven on the course of the vein northwest and southeast. The shaft for the first 200 feet has a pitch of 35°, from there to the bottom conforming to the pitch of the vein at an angle of 47°, the dip being to the east. The adit level carried in from near the level of Sullivan's Creek, south of the shaft, connects with it at a depth of 90 feet. Very little stoping has been done here. Below this 67 feet, or 757 feet below the collar of the shaft, drifts have been run both ways, to the northwest 46 feet and to the southeast about 40 feet. From the latter a stope was carried up to the adit on the vein.

On the third level, 323 feet below the mouth of the shaft, the northwest drift extends 230 feet, and about 215 feet on the opposite side. On the northwest, stoping has been done for a distance of 200 feet, extending in places to a width of from 16 to 20 feet.

The lower level, at a depth of 425 feet, has not been fully developed. The drift has been extended on the northwest side of the shaft 220 feet, and two upraises connect it with the level above, furnishing good ventilation in the lower workings and preparing extensive ore masses to be stoped.

On the adit level two distinct veins are marked, 60 feet apart, while on the third level two veins of distinctly marked character occupy th

same fissure. One of these is formed of brecciated quartz, while the other carries ribbon quartz. These veins show no intrusive matter between them; both are gold-bearing, and expand and contract, being never less than 3 feet, while sometimes reaching to a width of from 16 to 20 feet. The sulphurets comprise iron, copper, and lead, having molybdenate of lead associated with them.

There are employed at the mine fifteen men, including seven miners, three carmen, the mine foreman, timber man, blacksmith, and two engineers. The wages for miners and carmen are $2 50 per day, and $3 for the others, excepting the foreman.

The ten-stamp steam mill has 950-pound stamps, one Frue and two Woodbury concentrators, and canvased sluice tables, all operated by a sixty-five horse-power Hamilton Corliss engine. The mill employs two engineers at $3, two amalgamators at $3 50, and two Chinamen at $1 50 each. Five cords of pine wood is consumed daily, a portion of which is cut on the company's premises for $1 50 per cord. Mine timbers are obtained from the same source, and hauled by the company's teams, costing 2 cents per running foot. Part of the wood and timber is obtained from outside adjacent properties, the latter at a cost of 5 cents a foot, delivered. The company owns an abundant water supply, which can be made available at moderate cost for both mill and hoist, which it is presumed will ultimately be accomplished.

Mine drainage is effected by means of direct acting steam pumps, of which there are three—two special Wilcox pattern and one Hooker patent. In connection with these pumps a novel system of mine ventilation has been established, which consists in using the exhaust steam for suction purposes. Briefly described, air pipes of galvanized iron are carried into the various levels, and the pump stations are connected directly with a large sized exhaust steam pipe of the same material and somewhat above the immediate outlet of the steam from the cylinder. the escaping steam still containing force sufficient to create a suction from the open end of the air pipe, in the face of the drift. The pipe used for the steam exhaust is sufficiently large to serve as a jacket for the live steam finding its way to the pump, thus serving several purposes—prevention of rapid condensation of the live steam by the inclosing body of exhaust steam (it being the exhaust steam outlet), and as a suction pipe to carry off the foul air generated in the levels.

Adjoining on the northwest are other claims not being worked at present.

To the northeast of the Eureka lode, about 2 miles from Cherokee, is a group of mines along the line of the contact between the granite and the metamorphic slates. This contact going north gradually approaches the direction of the Eureka lode, which it would seem to strike about a mile above the Belleview Mine. The most of these veins appear to be the result of granite outbreak, and are located principally on the slate side of the contact, with a general northwest and southeast course, although a few of them have northeast strike, as for instance,

THE RISING SUN MINE,

Situated about 1 mile northeast of Arrastraville, on the east side of Turnback Creek. It is opened by a tunnel running north a distance of 225 feet, thence east a short distance, and finally to the north again. The

rock is exceedingly hard, requiring fifty drills to a 2-foot hole. At a distance of 450 feet from the mouth of the tunnel, an inclined shaft has been sunk on the pitch of the vein, about 30°, and has likewise been carried up to the surface. From the bottom of the shaft a drift has been run on the vein, from whence the ground has been stoped to the level above; the walls are very regular and smooth, dioritic, with no clay gouge between them and the vein. The mine makes about 6 miner's inches of water. A station has been cut out just above the level for the jack-head pump. The ore is said to be of very good grade.

Three miles north, at the village of Confidence, in the granite on the road from Sonora to Mono, is a detached group of mines that do not appear to be in any way connected with those previously mentioned, although near the contact, being between 4 and 5 miles to the northeast of the Eureka lode, and near the headwaters of Turnback Creek, which seems to mark the divide between the granite and the slate. There are four claims in the group, all extending in the same direction. They are, commencing south and going northward, the Independence, Confidence, Edith and Jessie, and the Lamphere.

Between the granite walls are three veins of quartz; that next to the hanging wall is from 2 to 5 feet wide, the middle vein from 5 to 20 feet, and a 2-foot vein next the foot wall; the rest of the fissure is filled with a porphyritic gangue.

THE CONFIDENCE MINE.

This is the oldest claim, and the whole fissure throughout is named after it. The property has been tied up through litigation. The value of the rock is stated to vary from $8 to $30 per ton and the concentrates $250; one batch was obtained that paid $600. The mine has been worked to a depth of 1,000 feet on an incline of 24°; 800 feet of this on the main incline, from whence a level 1,000 feet long was driven, below which a winze was sunk 200 feet farther on the vein, showing 60 feet of ore in the bottom.

Large reserves of ore, valued at $5 to $7 a ton, were left in the mine, as that grade could not be worked at a profit under the then conditions; the sulphurets were shipped to Swansea, in Wales. All the ore of a higher grade between the surface and the 800-foot level has been stoped. The motive power was steam, the company owning extensive timber land; the wood cost $2 75 per cord at the works. The works were badly wrecked during the hard winter of two years ago.

THE INDEPENDENCE MINE

Is the south extension of the Confidence, and is stated to be in all respects, as far as the ore is concerned, as valuable as that was.

THE EDITH AND JESSIE MINE

Lies between the Confidence and the Lamphere, and is nearly all virgin ground.

THE LAMPHERE MINE

Is the most northerly of this group, immediately adjoining the Edith and Jessie. It has an incline sunk 500 feet on the main or middle vein on an angle of 47°, the vein showing a width of 1 to 3 feet of ore along

the pay shoot; there are two shoots known, each about 60 feet in length. The ore is said to have yielded $14 per ton in free gold and $250 per ton of sulphurets; the remainder of the vein matter, about 5 feet in width, is said to average from $5 to $7 per ton. A second incline sunk on the hanging wall vein to a depth of 215 feet proved a vein from 2 to 5 feet in width, yielding similar to the above in free gold and sulphurets. The foot wall vein has not been explored. Five drifts have been opened: No. 1, for a length of 167 feet; No. 2, 217 feet; No. 3, 267 feet; No. 4, 317 feet, and No. 5, 417 feet. The two shafts have been connected through the workings. A nine-stamp mill belonging to these works contains a five-stamp battery and two batteries with only two stamps in each, used chiefly to crush the cheaper ore; also ore bins, self-feeders, aprons, and sluice plates, and three Frue concentrators. A twenty-five horse-power Corliss engine furnishes the power for the mill. The cost of the milling at that time was $4 per ton. Water power could be obtained for this whole group of mines, which should be operated together. The Lamphere Mine has a recorded yield of $100,000. All of these properties are held under United States patents. A drift can be started from the south side, on the Independence, and run through all the claims on the vein.

On the South Fork of the Stanislaus, in the slate belt east of the limestone that cuts through the whole county, and near the contact of the granite and slate, about 15 miles from Sonora to the northeast, is

THE KELTZ MINE.

This property is controlled by foreign capital (Scotch). The vein, striking a little east of north, has both walls in slate, but immediately to the east the granite contact can be found. On the east side, parallel to the vein, are several porphyry dikes. The vein was opened through three tunnels, 250, 450, and 300 feet long, distant from one another on the vein 170 feet from surface to No. 1, thence 135 feet to No. 2, and 400 feet to No. 3. The first tunnel crosscuts the slate for a distance of 130 feet to strike the vein, and then continues on the course of the same, the vein showing a width of from 1 to 10 feet, and dipping 33° to the east. Two thirds of this ground to the surface has been stoped out. From the second tunnel an upraise has been started preparatory to stoping. Two pay shoots, pitching vertically, have been found, one of which is 110 feet long, the other 50 feet. Most of the work in the mine is done by contract. On account of the position of the mine on a bluff overlooking the Stanislaus River, at a considerable altitude, it is most favorably located for exploiting through tunnels, and as there is little or no water in the mine, and timber surrounding the property, as well as free water power for a part of the season, with water the remainder of the time from the Tuolumne Ditch Co., for 15 cents per inch, and the ore being delivered immediately into the mill, over a tramway 450 feet long under an angle of 35°, on a loop track with a $\frac{5}{8}$-inch steel rope, the opportunities for cheap working are favorable in the extreme.

The ten-stamp mill carries 750-pound stamps, supplied with chrome-steel shoes and dies, which have an average wear of 1 inch per month, and cost, delivered, 10 cents a pound; between eighty-eight and ninety drops a minute are made; height of drop $4\frac{1}{2}$ inches, and height of discharge $2\frac{1}{2}$ inches, giving a duty of $1\frac{1}{2}$ tons per stamp in twenty-four

hours. Hendy self-feeders and a Dodge rock-breaker are used. No. 50 brass wire screens, placed vertically, 8 inches by 4 feet 2 inches in size, discharge the pulp onto a silvered apron and double sluice plates 16 feet long and 2 feet wide, with a grade of 1¼ inches. The company is preparing to put in Frue vanners, but at present has only a blanket plant below the sluices. The quartz, which is a ribbon rock with galena, iron, and some copper sulphides, is said to yield from $25 to $30 per ton in free gold and 2½ per cent of sulphurets. Two thirds of the gold is obtained in the battery, the remainder on the plates.

A 3-foot Knight wheel runs the mill at present. The company contemplates increasing their crushing capacity, in which case a power wheel will be erected at the river and the power transmitted, thus securing free water the whole year around; an air compressor is also to be put up, when the present method of ventilation by fan will be done away with. The tracking is supplied with steel rails 11 pounds to the foot. Eleven miners are at work and eleven men on the outside.

Colonel Dorsey is working some claims belonging to a group on the Stanislaus River, near American Flat, also situated near the contact between the slate and granite. They are

THE SNELL AND MONARCH MINES.

They are working on parallel veins striking to the northeast and dipping to the southeast in slate at an angle of about 40°. The veins show small on the surface, but widen out in sinking; the wall rocks are soft picking ground and can be worked cheaply. A shaft 100 feet deep has been sunk on the vein, with a drift 75 feet long on the pay shoot, where the ore shows 7 feet in width. The altitude of the mines is 2,700 feet above sea-level. Near the mines the river has cut through the lava flow that forms Table Mountain. The ore is said to pay from $50 to $100 per ton in free gold, with very little sulphurets, the gold selling at from $16 to $19 per ounce. The ore has been worked in an arrastra, which will be replaced by a water-power stamp mill, as a ditch 1,200 feet long will furnish 50 feet fall to an unlimited supply of water. Timber is plentiful, wages small (only $1 50 and board), and ground easily worked, the shaft being sunk for $2 50 per foot. Four men are employed at present.

Between the South Fork and Middle Fork of the Stanislaus River, not far from the Dorsey mines, is a claim known as

THE LAST CHANCE MINE.

The vein strikes to the northwest and dips to the east at an angle of 45°, gradually straightening up as depth is acquired, showing between walls from 3 to 5 feet wide. An incline 40 feet deep is sunk and drifts run on either side of the shaft, that to the north 40 feet and that to the south 35 feet in length. The quartz is free milling; said to yield $12 per ton, the gold being worth $18 46 per ounce. At present the ore is packed to a steam mill at an expense of $4 per ton.

Still farther along the Stanislaus River, in the granite formation to the north and west of Columbia about 3½ miles, is

THE GEM MINE,

Which has a ten-stamp mill and hoisting works run by a high pressure waterwheel. Another Gem Mine is in the county on the Mother Lode west of Jamestown.

THE MANZANITA CLAIM

Is nearer the river, joining on the Buzzard Roost. The vein is a blanket vein in granite, about 10 inches wide, with north and south strike and east dip, prospecting extremely well in the horn-spoon; the quartz is glassy. Several inclines have been started on the pitch of the vein. All the ore has to be packed to the mill.

THE CHLORINDA MINE,

On Stanislaus River, claims 2,200 feet on the vein, with 600 feet in width. The vein strikes 35° east of north, between granite walls, and pitches to the west about 80°. The main tunnel is 320 feet long, running in on the vein, which averages 3 feet in width, and is stated as yielding $4 per ton. Just below the tunnel and close to the bank of the Stanislaus River is a five-stamp mill run by an undershot wheel placed in the river under a 10-foot dam. The dimensions of the wheel are 11 feet diameter and 5 feet breast, with sixteen buckets in all, measuring 4 feet 5½ inches. The stamps are light, 650 pounds. A Tullock concentrator and feeder are near the mill, which is exposed to the weather.

THE BUZZARD ROOST MINE,

The extension of the Chlorinda, has a tunnel 140 feet long, the first 80 feet cut through the granite to the vein; turning on which, it is continued 60 feet, showing ore 3 feet wide. At the mouth of the tunnel is an 8-foot arrastra, worked by a 14-foot high pressure wheel, geared back.

MARBLE QUARRY.

Near the junction of the South Fork of the Stanislaus River with the main river, the limestone belt enters Tuolumne from Calaveras County several miles wide, and passing down southeast crosses the entire county. Near the lava flows that pass over the limestone to the east, a Scotch company are opening up a quarry of very fine marble. They own 160 acres of this limestone and have three varieties—the common vein marble, a very pure white that will compare favorably with Parian, provided age does not turn it yellow, and a reddish-tinted marble. They employ eleven men in all, and are facing up the quarry. The intention is to put up all the necessary machinery to cut, polish, and finish marble. At present two gangs of saws are in place, and they are preparing to put up a third. They derive their power from a 3-foot Dodd wheel. under 225 feet head; 60 inches of water is used, which is free. The price of the vein marble is from 5 to 8 cents a cubic foot. The other varieties have not been placed on the market yet. The company have their main warehouse in San Francisco, the freight to the railroad costing them $4 per ton.

WHITE LEAD GRAVEL CLAIM.

In examining this claim, on the northeast outskirts of Columbia, some interesting facts were observed. The claim comprises 10 acres, and is being worked at present at a depth of from 70 to 100 feet below the surface in a depression of the limestone. Similar holes filled with gravel have been worked to a depth of 200 feet, where the influx of water made further work impossible. The gravel contains gold throughout, and is not cemented. Nine tenths of the coarse gravel is large river wash, and the owner, Mr. M. C. Duchow, assures the writer that all of the largest bowlders, when found in place, were resting in the gravel on their narrow edge. Another fact which he stated was that in these white gravel leads they never found the smallest piece of limestone wash. In cleaning the boxes Mr. Duchow finds associated with the gold at the final panning out pieces of a metallic substance with crystalline structure. Having forwarded some larger pieces to the State Mining Bureau, they proved to be native crystalline tin with some iron, the first known occurrence of this metal in native state in the United States. Inquiries by the writer established the fact that in an early day in working the bars of the Stanislaus River above this point, the same substance was frequently found. As the big river wash found in this gravel claim is largely a dioritic granite, cropping out to the east farther up the river, none being in place in this immediate vicinity, the inference might be drawn that at a former period the same river that brought the tin to the bars of the Stanislaus River of to-day also carried it to these points, and that around its headwaters tin ore may be found.

Mr. Duchow employs five men. The gravel is hoisted by windlass and washed through 800 feet of sluices with rock riffles, using 40 inches of water, from the Tuolumne ditch. The gold obtained averages .957 fine.

To the west of Table Mountain, about 4 miles west of the town of Sonora, on the Mother Lode range proper, is a group of mines, the most prominent of which is the Rawhide Mine. It is in this neighborhood that the serpentine belt approaches the fissure, and forms, for a distance of several miles, the west wall of the Mother Lode, commencing at the Isabella and Gem Consolidated claim and extending south to the Crystalline Mine, where the diabase takes its place.

THE RAWHIDE MINE

Has been newly started with improved machinery, and modern methods of ore reduction are to prevail. In this part of the Mother Lode the surface indications extend for a great width, and an ore shoot 1,200 feet in length has been proved.

A new forty-stamp mill and hoisting works are in course of erection, and the sinking of the main shaft of three compartments, 4 by 5 feet in the clear, is being actively continued. Ingersoll drills and a Rix & Reynolds compressor are used. A chlorination plant, with a 3-ton reverberatory furnace, will form part of the outfit. The quartz carries arsenical pyrites, also tellurides, in all about 3 per cent. There are two shafts on the vein, 300 feet and 120 feet deep, reaching a vertical depth of 253 feet and 90 feet. The sinking cost about $30 a foot when sinking in the vein, and progressed at the rate of 2 feet per day. The mine

is 22 miles from the timber supply; sawed timber is used at a cost of $22 50 per thousand feet. There are really two veins, of which the western one has free-milling ores, while the east vein carries the tellurides and arsenates.

In the mill to be erected, which is to be of forty stamps, weighing 850 pounds, with steel shoes and dies, and all necessary adjuncts, such as self-feeders, concentrators, canvas plant, etc., the ore will be trammed direct from the hoist. The company uses 150 inches of water under a pressure of 150 feet, taken from the Tuolumne Company's ditch, which is brought onto a Pelton wheel. Two miles of road was built at a cost of $1,000. The present force comprises about forty men, half of them miners. The large amount of outside men at present is due to the erection of the works and buildings.

Northwest on the line of the lode, adjoining the Rawhide, is the Rappahannock, which has yielded rich ore in former days.

THE ALAMEDA MINE.

In following the lode north on this claim the serpentine no longer forms the west wall, but gives place to diabase, and at the north end that in turn is displaced by slate. The lode narrows for a short distance, but widens again to the north. An ore shoot, 1,000 feet in length, has been followed, carrying tellurides, and paying by mill process over $20 per ton. Numerous shafts and tunnels have been opened, but no great depth has been reached.

THE O. K. MINE.

The last of this group of mines going north, and belonging to the same parties as the Rappahannock, is entirely incased in slate. The main fissure here seems to be filled largely with wall material that has been united and partly replaced by quartz, more or less auriferous. From the location and topography of the country, tunnels can be run onto the vein from Mormon Creek. These two claims hold title to 3,300 feet on the line of the lode.

THE BADGER MINE.

Two miles west of the Mother Lode is a small mine working on a vein having the same general strike as the main fissure, near the contact of diabase and slate on Bear Creek, but being wholly in the slate; it dips to the east at about 60°, and shows in the bottom of the workings a 4-foot vein. A shaft 250 feet deep is sunk on the vein, and at the 200-foot level drifts have been run north 80 feet and south 70 feet, at a cost of $4 a foot, developing pay for a distance of 150 feet; on the surface the pay has been traced 600 feet. All the ground is well timbered with both round and sawed pine timber, procured about 1 mile from the mine, and costing 5 cents a foot. The ore is ribbon quartz, carrying 1½ per cent of sulphurets, mostly iron, these assaying $300 per ton. Up to the present the ore has been crushed in custom mill, paying about $14 50 per ton in free gold, and costing $7 per ton to haul to the mill. A ten-stamp mill and a hoisting works are to be erected, to be run by water power, applied to a Pelton wheel, under pressure of 190 feet. Concentration plant, consisting of Frue vanners and a canvas plant, is also to be added. Eight men are employed, six in the mine.

Following the Mother Lode down south after it crosses the volcanic flow which constitutes Table Mountain, but little mining activity is seen until Quartz Mountain is reached. The mines that are working are the Dutch Mine and the New Era.

THE DUTCH MINE

Is situated in the village of Quartz Mountain, on the main lode, of which it holds 1,400 feet in length by 300 feet in width. Four shafts are sunk on the vein to a depth, respectively, of 210 feet, 130 feet, 120 feet, and 80 feet. The work at present is being carried on at the south end of the claim, a drift being run from the bottom of the shaft about 40 feet on the vein, which shows strong; a crushing of everything between the walls paid $3 per ton. One ore shoot has been followed 100 feet, being still in ore. The mine makes about 300 gallons of water per hour, which is hoisted by horse power. It cost about $7 per foot to sink on the vein; 1 foot per shift is usually sunk. The ore is ribbon quartz, carrying iron, galena, tellurides, and arsenides; it assays from $68 to $125 per ton. The ore is hauled to the App mill at a cost of 25 cents per ton. This mill is old fashioned and contains one five-stamp battery run by a 16-foot overshot wheel with a 4-foot breast. Only three quarters of a ton to the stamp can be crushed, using No. 40 brass wire screens. There are no appliances for concentrating or saving the sulphurets.

For hoisting at the Dutch Mine a donkey engine is used. The company will put up a complete ten-stamp mill of its own, with concentration plant. The average width of the vein matter is 300 feet.

THE NEW ERA MINE,

In close proximity to the above, has an average width of from 12 to 100 feet on the vein, and an ore shoot over 750 feet in length. It has but four shafts, the deepest about 100 feet, which cost $8 a foot to sink, working at the rate of 2½ feet a day in vein matter. The ore is crushed in the App mill, costing 50 cents a ton to haul; it carries free gold, and 1½ per cent of sulphurets, similar to the above. Four men are employed.

THE MAZEPPA MINE.

Located where the lode crosses Sullivan's Creek, on the north bank. The west wall is diabase and serpentine, the hanging wall slate. The vein shows a body of ore about 6 feet wide on the eastern side of the ledge; on the main body of the lode the ore does not carry much gold per ton. A shaft 7 by 6 feet is sunk a depth of 30 feet on the east vein. Prospecting is being done with three men, and the ore is hauled to the App mill for reduction. They pay $2 25 per ton for hauling and milling.

Continuing south 2 miles, on the contact of the slate and the diabase, to the neighborhood of Jacksonville, a dozen claims have been recorded along the line of the lode, and considerable money expended toward development, but little actual activity is manifested at present. The Shawmut Mine, which is supplied with a ten-stamp mill, is apparently making some effort to resume operations, and the Gladstone and Stanley

Mines, near the Tuolumne River, are being worked by the owners and a few men.

THE GLADSTONE MINE

Is operating on the eastern side of the fissure. Two tunnels have been run into the hill through slate, one 600 feet, the other 360 feet; this part of the ground is pockety. A diorite dike, dipping about 30° west, cuts through all the formations here, both slate and porphyry, faulting them. The pockets are found in the slate where it abuts with the porphyry, the gold often assuming the wire form; its value is $17 per ounce.

THE STANLEY MINE,

Belonging to and being worked by the same parties, contains a large body of low-grade ore, which can, however, be broken and delivered to the mill very cheaply. The ore carries from 2½ to 5 per cent of a low-grade sulphuret, averaging from $20 to $50 per ton, and the body of it shows a width of from 100 to 150 feet. A ten-stamp steam mill was put up for prospecting purposes. An open cut with a face 75 feet across has furnished most of the ore crushed. The foot wall here is serpentine, the hanging wall slate.

THE KINCAID FLAT MINING COMPANY.

Three miles southeast of Sonora and east of Jamestown, near the contact of the slate and gneissoid rock, the above company own 160 acres of ground, where they are working a gravel deposit. From Sullivan's Creek a tunnel has been run, starting at Sullivan's Bar and running 3,000 feet under Kincaid Flat. A shaft 140 feet in depth was sunk, but neither tunnel nor shaft touched bedrock; the shaft could not be sunk any farther, on account of the difficulty of handling the water. The gravel is from 40 to 50 feet wide, not cemented, and pitching like a vein, at an angle of about 45° to the east. What would represent the foot wall is a greatly decomposed rock, having lost all structural features. The gravel carries coarse gold, valued at $19 per ounce. It is washed by hydraulic process. Curtis Creek, to the south, furnishes 600 inches of water under 160-foot pressure, which is delivered against the gravel through a Giant No. 3, with a 3-inch nozzle. The flume is 2 feet in width and about 1,200 feet long, with a 2-foot fall to 100 feet; a part of the flume is paved with block riffles, and the rest with slats, but the expense of renewal of these latter being too great, the blocks will be used throughout in the future. Except in a general clean-up the first 120 feet only is cleaned. The open cut beyond the tunnel is 550 feet long, 50 feet wide, and the bank about 60 feet high. The east side is a gneissoid rock, the west a slate, pitching about 80° to the east. The hydraulic pipe is 11 inches in diameter, made of No. 16 iron. The flume and tunnel cost in construction $85,000. Some part of the slate cost $30 per foot to drive through. At present four men are at work, who receive $3 per day.

THE GOLDEN GATE MINE,

One of the most prosperous mining undertakings in the county, with a complete plant, is within a mile of the town of Sonora, and operates on a vein coursing northeast, apparently an offshoot of the main lode fissure. Since last reported on, the following work has been progressing: On the 200-foot level north of the shaft, on a pay shoot which extends for a length of 350 feet, the end not having been reached yet, the ground is being stoped toward the surface. On the 300-foot level north of the shaft, the drift has attained a length of 320 feet, and is still being continued to the south; the drift has been stoped a distance of 60 feet. The inclined shaft is down 470 feet, about 400 feet vertical. A new Rix compressor is to be put in for six drills, Ingersoll pattern.

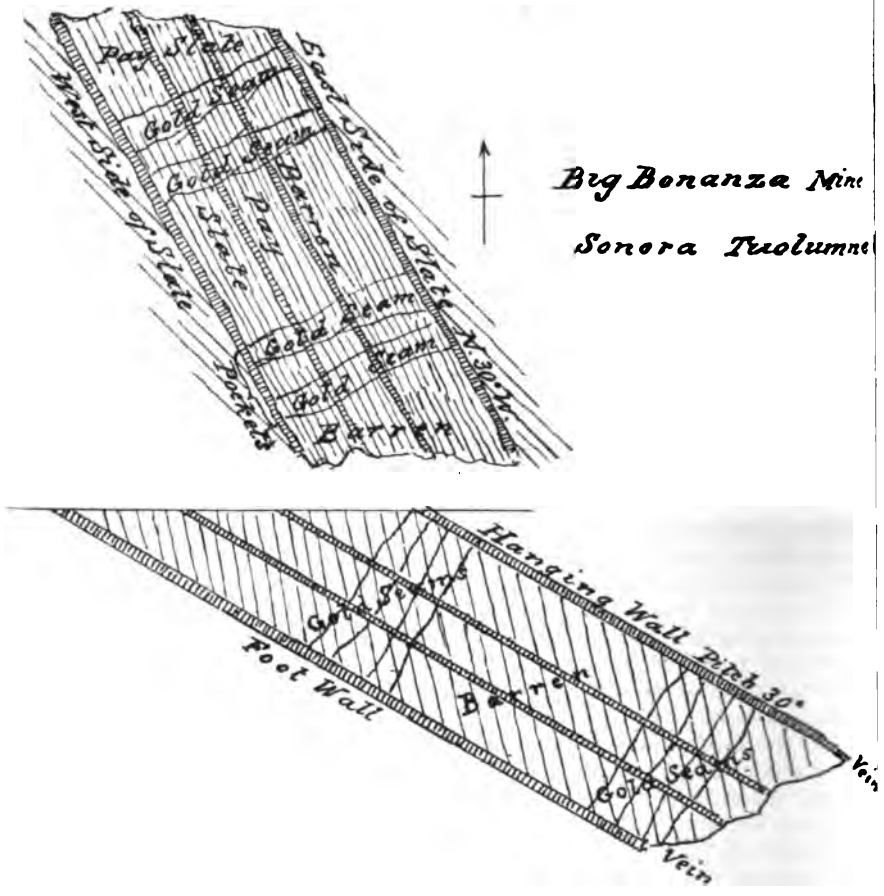
The shaft, which is in the foot wall, about 8 or 12 feet from the vein, in a dioritic dike, cost $30 per foot to sink; 180 feet of the shaft has been sunk since October, 1891, and the surface tunnel retimbered throughout. The opening of the entire 300-foot level and from there down to the bottom of the shaft has been executed since issuing the last report.

The chlorination plant has been erected for 3 tons per day, using an old-style Plattner furnace. The ore yields about 5 per cent of sulphurets of iron, lead, and copper, also arsenical pyrites and tellurides, which are saved on four Frue vanners with corrugated belts, canvas plants and settlers, and yield, by the chlorination process, 97 per cent of the assay value, the treatment costing $14 per ton. The furnace consumes two and a half cords of wood, valued at $4 25 per cord, for every 3 tons of concentrates. Since being started up the chlorination works have been idle only two weeks.

In the mill, which is run at the high rate of one hundred and five drops per minute on a 6-inch drop, 2½ tons of ore is crushed per stamp, passing through a No. 30 screen. The wear on the chrome-steel shoes and dies amounts to 1 inch per week. The free gold is saved almost entirely on the plates. The power is water, taken from the Tuolumne Company's ditch under private contract, and is distributed as follows: Three wheels at the hoisting works—two Knight wheels 6 feet in diameter, and a home-made undershot for the compressor; a 6-foot Pelton wheel for the mill, a 20-inch Pelton for the concentrators, and an 18-inch Pelton for dynamo and lathe. The water at the mill is delivered under a 300-foot pressure, at the hoisting works with 260-foot head. A seventy-five horse-power engine with two tubular boilers is in reserve at the mill, in case of accident to the water power. Ten stamps with the necessary concentrators, among which will be introduced a new Danbury concentrator from Colorado, are to be added. All of the works use electric lights. About forty men are in the employ of the company; twenty-eight of them are miners.

THE BIG BONANZA MINE

Is engaged at present in erecting an entirely new hoisting and pumping plant, which is about completed, when the mine will be drained and the work resumed. There will be three pumps—a Duplex, a Hooker, and a jack-head. The company take water from the Tuolumne Company's ditch, with 393-foot fall, applied through 3,000 feet of 11-inch p



made of No. 14 and No. 16 iron, with ¾-inch nozzle, acting on a 3-foot Dodd wheel. They have also a thirty-two horse-power engine for reserve power.

This noted pocket mine, situated within the town limits, has a vein coursing north 30° east, dipping at an angle of 30°, while the slates of the country rock have a course north 45° west. The vein is about 8 feet in thickness. The vein filling, consisting of a porphyritic dike, has a casing of quartz on each side, also two quartz stringers near the center, holding the same course as the vein. Parallel to the slates, and running between them, are four strata, locally called crossings, apparently an altered condition of the slate; these are cut off by the quartz vein. The vein is traversed by small seams, which, when closely examined, show small crystals of sulphurets and sometimes gold. These are the gold seams of the pocket miner, and run at right angles with and through the crossings; these he carefully follows to the vein, when, if it is at all gold-bearing, it will make a pocket on the contact. These pockets appear to have a solid gold nucleus, surrounded by concentric rings impregnated with gold in a greater or less area. The above figure.

taken from a drawing by J. C. Dart, M.E., shows the relative positions of the different parts.

A body of water equal to 8 miner's inches flows into the mine. As the mines of Tuolumne County are so much dependent on a close saving and beneficiating of their sulphurets to bring them to a paying basis, it is a move in the right direction that all the new mills devote considerable space to the erection of different kinds of concentration plants, while the older works are adding canvas platforms behind their mills to obtain closer percentages than heretofore. It is in this direction that the establishment of the Sonora Chlorination Works is a direct benefit to all the smaller mines that do not feel able to erect and maintain works of their own. These works are at present in the hands of reliable and conscientious men, and consist of a four-stamp battery with 750-pound stamps, apron, and small sluice plate, a Dodge crusher and self-feeder, a Tustin dry crusher mill, a sampling floor; a single-hearth, long, reverberatory furnace, 36 feet by 12 feet outside measurement, with nine working doors, and a capacity for 2 tons in twenty-four hours; three chlorination vats, one settler, and two precipitating tubs for silver, also a precipitating tank for cement copper, assay office, etc. They guarantee 90 per cent of the fire assay for all up to $50 per ton, higher percentages in proportion for richer ores. Their charges are $20 a ton for gold, $5 additional for silver. Three men are employed besides the manager.

YOLO COUNTY.

FLOWING WELL ON DINSDALE RANCH.

A flowing well was obtained at the Dinsdale ranch, 3 miles east from Woodland, at a depth of 145 feet; it is a 5-inch well, and yields about 300 gallons of water per minute. The formation penetrated is as follows:

Soil	10 feet.
Washed gravel	16 feet.
Hardpan and yellow clay	74 feet.
Clean sand	14 feet.
Water, which rose to the surface but did not flow.	
Red clay mixed with fine gravel	11 feet.
Clean gravel.	

At this depth flowing water was struck. The water flowed from the casing at the height of 34 inches above the ground.

YUBA COUNTY.

By W. L. Watts, Assistant in the Field.

WATER AND NATURAL GAS IN THE VALLEY LANDS OF YUBA COUNTY.

Between Marysville and the northern boundary of the county, throughout districts lying on the western side of the railroad, and extending for several miles to the eastward therefrom, except where spurs run down from the hills into the valley, an abundant supply of water can be obtained at a depth of from 10 to 12 feet. The formation is about as follows:

Sandy loam	2 to 20 feet.
Hardpan, sometimes absent	2 to 10 feet.
Gravel, with a good supply of water.	

Wells through these districts are usually bored to the depth of from 20 to 30 feet, but the water stands at a depth of about 10 feet. Toward the eastern hills the water lies deeper, and in boring difficulty is encountered from bowlders; most of the wells are dug. Water is also flumed from springs in the hills.

The city of Marysville is supplied from two 12-inch wells, one bored in 1850 being 80 feet in depth, and one bored in 1872 being 180 feet deep. During the summer more than 1,000,000 gallons of water is supplied from these wells every twenty-four hours, and during the winter about 300,000 gallons.

At the Buckeye Mill, in Marysville, a well was bored in 1888 to a depth of 218 feet, and the following formation was observed:

Reddish clayey loam	12 feet.
Sand, with water	8 feet.
Gray hardpan	20 feet.
Blue clay	20 feet.
Coarse blue sand and water	6 feet.
Coarse gravel, sand, and water	25 feet.
Blue clay	30 feet.
Blue cemented sand, dry	2 feet.
Hard blue clay	30 feet.
Coarse sand and gravel, with an abundant supply of water	10 feet.
Alternate strata of yellow and blue clay and sand to the bottom	55 feet.

The well-borers state that the principal supply of water came from the coarse sand and gravel at a depth of 153 feet. After pumping with a steam pump the water stood at the height of 4 feet from the top of the well.

South from Marysville, following the railroad, water is very abundant, and the formation is very similar to that observed to the north of the town.

At Colema, between Marysville and Reed's Station, an orange and olive orchard and vineyard of about 225 acres are irrigated by pumping from bored wells that are about 50 feet in depth, the water rising to within

10 or 12 feet of the surface. It is said that more than 500 gallons per minute have been pumped from these wells for several consecutive days without appreciably lowering the water; but when 1,000 gallons per minute were pumped it lowered the water about 4 feet.

IRRIGATION.

Irrigation in Yuba County is represented by the Brown's Valley and the Excelsior Irrigation Districts.

The Brown's Valley Irrigation District, which was organized under the Wright Act, diverts water from the North Yuba River, about 3 miles west of San Juan, in Sierra County. The district comprises some 43,000 acres, lying between the main Yuba and Honcut Creek. The water is brought by canal and flume a distance of 28 miles, to high land on the eastern side of Dry Creek, about 8 miles northeast from Brown's Valley. At this point the water is dropped down a ravine a vertical distance of about 300 feet; thence it is taken through a pipe across a suspension bridge to the western side of the creek, and distributed throughout the irrigation district. It is estimated that the main ditch will carry about 5,000 miner's inches of water.

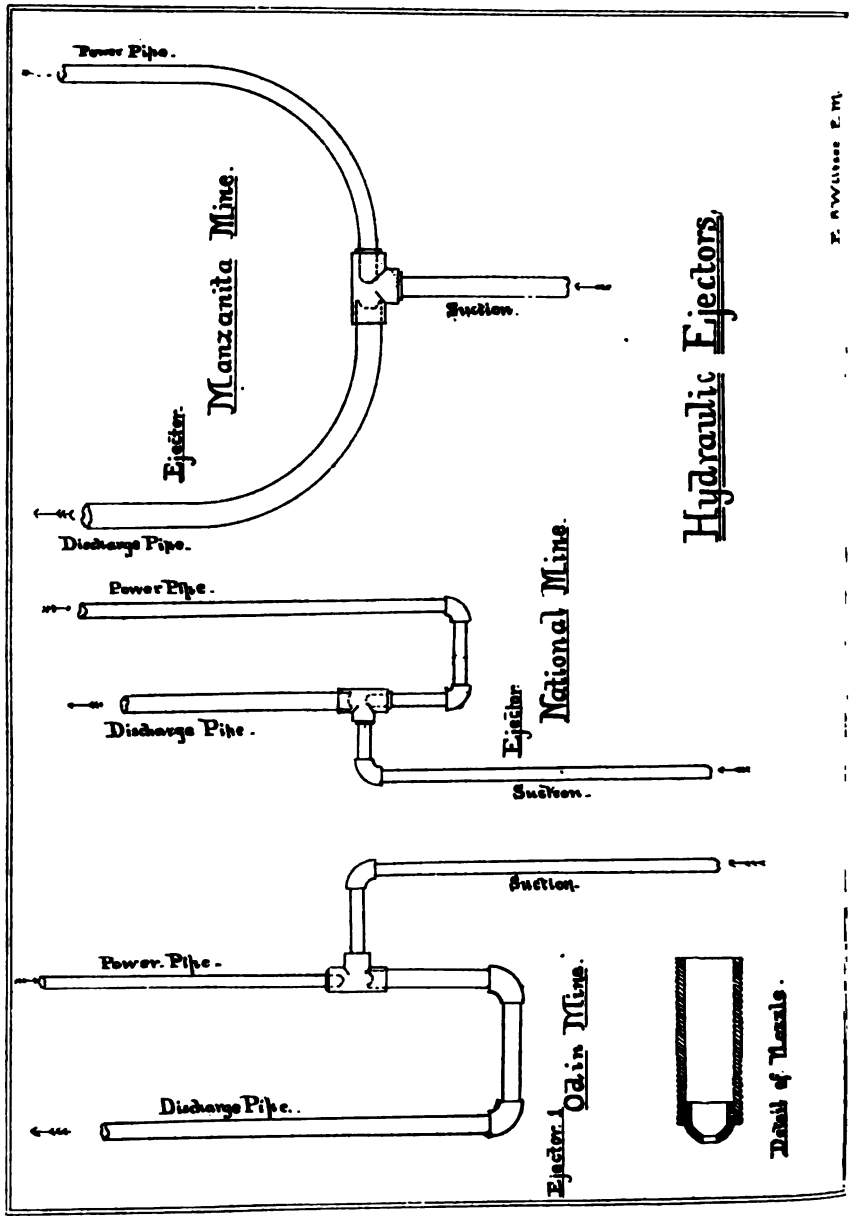
HYDRAULIC EJECTORS.

By E. A. Wiltsee, E.M.

This ingenious device for the elevation of small quantities of water without the aid of pumping machinery has found quite a widespread application among the drift gravel mines of Nevada City, Nevada County, where the quantity of water is small, and water power under high head easily procurable. The contrivance depends upon the principle of induced currents for the raising of the water into the pressure stream immediately in front of the nozzle; once there, it is elevated to the surface simply by the force and velocity of the larger stream of power water, which makes the ascent of the discharge pipe under the influence of its heavy head.

The arrangement of the machine, if such it can be termed, is quite simple, and is shown in the accompanying sketch. The component parts are: The pressure pipe from surface, down which the power stream is conveyed; an ordinary "tee," into which the power water discharges through an internal nozzle, to be received in an internal receiving nozzle of slightly larger diameter an inch or two away. Into the branch arm of the "tee" the suction pipe from the sump is fitted, so as to deliver the water, induced by the vacuum formed, into the pressure stream between the "tee" nozzles; and lastly, the discharge pipe to surface, a little larger in diameter than the power pipe conducting the pressure stream down.

The construction of the nozzles is very simple. The fitting entering the "tee" is a nipple, to which the pressure pipe is attached externally by a coupling. On the inside of the nipple is riveted a blunt nozzle with the necessary aperture, as shown in sketch. The receiving nozzle is of the same description, but a little larger in diameter, and riveted into the end of the nipple entering the other end of the "tee" and to which the discharge pipe is coupled. The nozzles are thus adjustable within a certain distance by means of the nipples, and in small machines this has been found ample. The construction of the nozzle is shown in the sketch. The size of the nozzles used on these small arrangements is usually three eighths of an inch in diameter for the pressure nozzle, and five eighths of an inch for the receiving nozzle. This proportion does not seem to be absolute, the requirements of the contrivance being that the receiving nozzle shall be large enough to receive the pressure stream and the added water to be elevated, and near enough to the pressure nozzle to collect and receive the stream before it breaks and scatters. A valve should always be placed in the power pipe near the "tee," in order to turn off the power water in case of any accident to any part of the apparatus; it would also be advisable to have a large valve in the discharge pipe near the device, if the discharge were of any considerable size and contained any large quantity of water.


Hydraulic Ejectors.
Manzanita Mine.
Power Pipe.
Ejector.
Suction.
Discharge Pipe.
National Mine.
Power Pipe.
Discharge Pipe.
Ejector.
Suction.
Odin Mine.
Suction.
Power Pipe.
Discharge Pipe.
Ejector.
Detail of Nozzle.

Three arrangements of the device are shown in the sketch, not because all are deemed advisable, but as representing the three types found in actual use.

No. 1.—That used in the Odin Mine; is the worst of the three, and is considered by the writer an example of "what not to do." In this arrangement the power stream, after entering the receiving nozzle and having the additional stream to be elevated, is forced around two right angle turns, and necessarily loses a large proportion of its velocity, power, and working force.

No. 2.—In use at the National Mine, and the original device of the inventor, or designer, is to the mind of the writer by far the best mechanical device. The full power stream is led around the turns before its discharge from the nozzle, and the discharge, when it does take place through the reduced nozzle, is straight up in the direction in which its work is, with no impediment or obstacle in its path, except the natural friction of the straight pipe.

No. 3.—The arrangement in use at the Manzanita Mine; while not so bad as No. 1, would seem to impair the force of the working stream to some extent by reason of the heavy friction entailed by leading the stream around the bend preparatory to its upward flight. As the design has been used but a short time, though with great success in every case, it was impossible to get any exact figure as to the amount of work done, or percentage of power realized from the working stream. As nearly as the operators of the device could state, about one quarter to one third of the number of inches of water employed in the power stream were raised from the water of the mine. In other words, a power stream of 4 miner's inches would elevate with it 1½ miner's inches from the mine. It is to be hoped that the users of this arrangement will carefully measure both streams and ascertain the exact amount.

The power water was employed under various heads, varying from 600 feet in the Odin Mine to 200 feet in the National Mine. The water was elevated 180 feet in the Odin Mine, 210 feet in the Yosemite Mine, and 100 feet in the National Mine. As the power water is delivered at the bottom of the shaft or workings, the working head will always be increased by the vertical distance from the surface, in addition to the head of power water at that point.

The nozzles are placed, in these small arrangements, at distances of from 1 to 2 inches apart. The adjustment is made by trial after the device has been put together. The designer of this form of hydraulic ejectors is Mr. Rounder, of the National Mine, and to him is due the credit of the application of the principles involved.

The application of the device, while somewhat limited, is of considerable importance. By its use all heavy expense for pump columns and attendant machinery is saved—no small item in prospecting operations. While it has not as yet been tried here on a large scale, to the knowledge of the writer, it is certain the operation would be successful, the only question being as to whether its operation would be economical, on account of the small percentage of the power realized. Where water power is free this item would not enter into consideration; but when the quantity of water to be raised is small, and the distance to be elevated not too great, and when water power can be obtained under heavy head

The exodus to California in the time of the gold fever, followed as it was by the discovery of the gold of Australia, pushed forward the onward march of events with an intensity and a rapacity never before known. In a large sense it constituted an awakening of the human mind. It disclosed possibilities, developed energies, and promoted activities fraught with influences still affecting the destinies of the race.

As the intended scope of this article is to present some considerations of a practical nature, and more especially some legal aspects to which the subject invites, we can now only briefly indicate, before passing to our main purpose, some of the more manifest outgrowths of the California gold excitement. It widened the scope of vision, and broadened and strengthened individual character. This is illustrated by the fact that the greatest soldiers of our late war had received an impress from life along the vitalizing influences of a society loosened from tradition. Grant, Sherman, Sheridan, Halleck, Hooker, Albert Sidney Johnston, and many others of martial achievement had lived in California.

It is not too much to say that a new species of literature blossomed from the fermenting influences of California life. Invention in mechanical art was stimulated and received an impulse, the bounding current of which is still headed toward the consummation of much for the comfort and in aid of the race.

The production of gold and silver gave staying power to the Government while engaged in a struggle for national life. It has built temples to science that are the admiration of nations that had long been in vigorous life when Isabella pledged her jewels in behalf of the Genoese adventurer. It has breathed civilization, vigorous and aggressive, into an empire of its own creation, and given as pledge for its perpetuation the means of universal mental development. It has reacted upon the sleepy provincialism of older communities, and taught them a broader sense of the immensity of our domain and the indissolvable links of a common destiny. It has demonstrated the possibility, under a free government, of the people by their own industry creating for themselves a safe means of commercial exchange, and thus enhancing the possibilities of industrial pursuits. It has been a crusade against blind tradition, an unreasoning adherence to the old, merely because it is old, more far-reaching and infinitely more beneficial than all the religious crusades of mediæval times. All this has been done in the latter half of the nineteenth century, and by men many of whom will live to herald the dawn of the twentieth century.

Who shall say that mines and mining is not one of the impellant onward forces?

The purpose of the foregoing references has not been so much to point out the glories of material advancement, as to delineate in perspective that which is the crowning glory of all; that from which results law, order, liberty, protection to person and property, a sacred regard for the rights of others, joined with an absolute independence of individual effort in security, a security based upon reason and a sense of moral obligation. The aptitude of the American people for such achievement the American mining law amply proves, and the course of its advancement, the history of its growth, should be interesting as well to the student of law as to the miner whose welfare is dependent upon its due administration.

Let us examine with more or less detail the constituent elements out

of which the system has been evolved. These may be stated generally to be:

First—The customs and regulations of miners themselves.
Second—State and Federal legislation and Federal treaties.
Third—Spanish and Mexican law.
Fourth—Judicial decisions.

In the days of early mining in California and elsewhere, from the very necessity of the circumstances in which the miners found themselves, customs grew up which soon became a guide for all, or in mass meetings regulations were adopted concerning mining rights, and rules as to working them, which had the force of law in the locations where adopted, and constitute the American common law on mining for precious metals.[1] These meetings were held at a known place in the district, upon previous notice that the meeting would take place for the purpose intended, either to establish the laws for the first time, or to alter or repeal those formerly established. One of the miners present acts as the presiding officer, another as Secretary, who keeps a record of the proceedings of the meeting, and afterwards hands the laws adopted to the Recorder elected, who records them, as directed, in a book kept for that purpose. The laws are adopted in the usual way of conducting public meetings, without much regard to Jefferson's Manual, but with the business tact of American instinct for public meetings. In regard to the notice for the meeting, there is a decision which may be given: "There is," says Mr. Justice Baldwin, in Gore vs. McBrayer (18 Cal. 588), "nothing in the point that the mining laws offered in evidence were passed on a different day from that advertised for a meeting of miners. We cannot inquire into the regularity of the modes in which local legislatures or primary assemblages act. *They must be the judges of their own proceedings.* It is enough that the miners agree, whether in public meeting or after due notice, upon their local laws, and that these are recognized as the rules of the vicinage, unless some fraud be shown, or some other like cause for rejecting the laws."[2]

Senator Stewart, the author of the Act of 1866, in advocating its passage in the Senate, spoke in high praise of the regulations and customs of miners, and portrayed in glowing language the wonderful results that had followed the system of free mining, which had prevailed with the tacit consent of the Government. The Legislature of California, he said, had wisely declared that the rules and regulations of miners should be received in all controversies respecting mining claims, and when not in conflict with the Constitution or laws of the State, or of the United States, should govern their determination; and a series of wise judicial decisions has molded these regulations and customs into "a comprehensive system of common law, embracing not only mining law, properly speaking, but also regulating the use of water for mining purposes." The miner's law, he added, was a part of the miner's nature. He made it, he trusted it, and obeyed it. He had given the honest toil of his life to discover wealth, which, when found, was protected by no higher law than that enacted by himself under the implied sanction of a just and generous government.[3]

Most of the local rules and customs are easily recognized by those

[1] King v. Edwards, 1 Mont. 235.
[2] Yale on Mining Claims, 73.
[3] Jennison v. Kirk, 98 U. S. 453.

familiar with the Mexican law, the Continental Mining Codes, especially the Spanish, and with the regulations of the Stannary Convocation among the Tin Bounders of Devon and Cornwall, in England; and the High Peak Regulations for the lead mines in the county of Derby.

General Halleck ascribed to them a more limited origin. In his introduction to the translation of De Fooz, he says: "But the miners of California have generally adopted as being best suited to their peculiar wants, the main principles of the mining laws of Spain and Mexico, by which the right of property in mines is made to depend upon the *discovery* and *development;* that is, *discovery* is made the source of title, and *development*, or working, the condition of the continuance of that title. These two principles constitute the basis of all our local laws and regulations respecting mining rights.[4]

These regulations are founded in nature, and are based upon equitable principles, comprehensive and simple, have a common origin, are matured by practice, and provide for both surface and subterranean work, in alluvium, or rock *in situ*.[5]

The rules and regulations originally established in California have, in their general features, been adopted throughout all the mining regions of the United States. They were so wisely framed and were so just and fair in their operation that they have not to any great extent been interfered with by legislation, either State or National,[6] and they are subject to the same rules of construction as statutes.[7] But the rule, regulation, or custom to be valid must not only have been established but it must be in *force* in the district at the time the location is made. It does not, like a statute, acquire validity by the mere enactment, but from the customary obedience and acquiescence of the miners following its enactment. It is void whenever it falls into disuse and is generally disregarded.[8]

It will be presumed that a party in possession of a mining claim holds in accordance with the local rules and customs of the district.[9] All mineral locations made before the enactment by Congress of any law governing the subject are to be regulated by the local rules and customs in force when the location was made;[10] but if a mining claim, actually possessed and worked for several years, has been generally recognized as validly made, the claimant's title is good, though the mining rules in force when the location was made were not fully observed in making it. This is especially the rule as between co-tenants and those claiming through them.[11] The Courts have always sustained rights that grew up under them, and the Code of Civil Procedure of California declares that "in actions respecting mining claims, proof must be admitted of the customs, usages, or regulations established and in force at the bar or diggings embracing such claim; and such customs, usages, or regulations, when not in conflict with the laws of this State, must govern the decision of the action."[12] This is in terms a reënactment of Section 621

[4] De Fooz, 5, 7. See also King v. Edwards, *supra*.
[5] Yale on Mining Claims, 58.
[6] St. Louis v. Kemp, 104 U. S. 636.
[7] Rush v. French, 1 Ariz. 99.
[8] 15 Am. and Eng. Ency. of Law, 561.
[9] Robertson v. Smith, 1 Mont. 410.
[10] Glacier v. Willis, 127 U. S. 471.
[11] Kinney v. Con. Va., 4 Sawy. 382; Mt. Diablo v. Callison, 5 Sawy. 439.
[12] See Deering's C. C. P. of Cal. and a note thereto giving reference to numerous decisions in California as to the rights of parties under local rules.

of the "Practice Act" of California, and the views of the late Judge Sanderson announced upon this subject are as follows:

"At the time the foregoing became a part of the law of the land, there had sprung up throughout the mining regions of the State local customs and usages by which persons engaged in mining pursuits were governed in the acquisition, use, forfeiture, or loss of mining ground. (We do not here use the word forfeiture in its common law sense, but in its mining law sense, as used and understood by the miners, who are the framers of our mining codes.) These customs differed in different localities, and vary to a greater or less extent according to the character of the mines. They prescribed the acts by which the right to mine a particular piece of ground could be secured, and its use and enjoyment continued and preserved, and by what non-action on the part of the appropriator such right should become forfeited or lost, and the ground become, as at first, *publici juris*, and open to the appropriation of the next comer. They were few, plain, and simple, and well understood by those with whom they originated. They were well adapted to secure the end designed to be accomplished, and were adequate to the judicial determination of all controversies touching mining rights. And it was a wise policy on the part of the Legislature not only not to supplant them by legislative enactments, but on the contrary to give them the additional weight of a legislative sanction. These usages and customs were the fruit of the times and demanded by the necessities of the communities who, though living under the common law, could find therein no clear and well-defined rules for their guidance applicable to the new conditions by which they were surrounded, but were forced to depend upon remote analogies, of doubtful application and unsatisfactory results. Having received the sanction of the Legislature, they have become as much a part of the law of the land as the common law itself, which was not adopted in a more solemn form. And it is to be regretted that the wisdom of the Legislature in thus leaving mining controversies to the arbitrament of mining laws, has not always been seconded by the Courts and the legal profession, who seem to have been too long tied down to the treadmill of the common law to readily escape its thraldom while engaged in the solution of a mining controversy. These customs and usages have, in progress of time, become more general and uniform, and in their leading features are now the same throughout the mining regions of the State; and however it may have been heretofore, there is no reason why Judges and lawyers should wander, with counsel for the appellant in this case, back to the time when Abraham dug his well, or explore with them the law of agency or the statute of frauds, in order to solve a simple question affecting a mining right, for a more convenient and equally legal solution can be found nearer home, in the 'customs and usages of the bar or diggings embracing the claim' to which such right is asserted or denied."[13]

The extent of a mining district may be changed by those who created it, if vested rights are not interfered with.[14] Miners are still permitted, in their respective districts, to make rules and regulations not in conflict with the laws of the United States, or of the State or Territory in which the districts are situated, governing the location, manner of recording, and amount of work necessary to hold possession of a claim.[15] And a

[13] Morton v. Solambo, 27 Cal. 523.
[14] King v. Edwards, *supra*.
[15] Erhardt v. Boaro, 113 U. S. 527.

corporation interested in mining may be represented by any of its officers or agents at any meeting of miners called together to frame rules and regulations in their mining district.[16] But in order that mining claims may be held and the Government title acquired, it is not essential that mining districts should be organized and local rules adopted, and in the absence of local rules a compliance with the public law will secure the claim.[17]

In 1848 the treaty between the United States and Mexico, following the Mexican War, was ratified.[18] By that treaty California, Arizona New Mexico, Texas, and that part of Colorado south of the Arkansas River were ceded to the United States. That year gold was discovered in California, and soon thereafter began the exodus of the gold-seekers from the Eastern States and elsewhere to the Pacific Coast. The effect of the treaty was, of course, that the Government of the United States became the land owner of all that part of the ceded territory to which, under the treaty, some private right of ownership had not attached. Up to that time, and even until a later period, as we shall see, congressional legislation with regard to minerals had been sporadic and unimportant. There had been some legislation as to salt springs, the leasing of lead mines, and the sale in Michigan and Wisconsin of lands containing copper, lead, or other valuable ores, but no general scheme in regard to minerals. Our forefathers of the thirteen original colonies inherited the common law of England, and under that law all gold and silver mines (speaking in general terms) belonged to the crown. The citizens of that portion of Mexico ceded to the United States inherited the laws of Spain. Under the laws or ordinances of Spain certain rights were conferred upon the discoverer of gold and silver mines, and regulations were prescribed for working them. These ordinances, at the time of the cession somewhat modified by Mexican law, furnished an established system in relation to mines of gold and silver, and as before said, some of the features have been blended into the miner's customs and regulations.

On July 26, 1866, Congress passed the Act that was the first effort by the Federal Legislature to create and establish a system of Federal mining law.[19] It marked a new era in the development of the American legislation, and yet it is a singular fact to note, in passing, that in its title, mines are not mentioned, nor the purpose of the Act disclosed. It reads: "An Act granting the right of way to ditch and canal owners over the public lands, and for other purposes." The explanation of it is an interesting fact in the history of congressional legislation. Mr. Gregory Yale explains it, as follows:

"The miners of California, and of the States and Territories adjacent thereto, have but a very inadequate idea of the imminent peril in which the pursuit in which they are engaged was placed at the commencement of the Thirty-ninth Congress. Two years ago there was a strong disposition in Congress and the East generally to make such a disposition of the mines as would pay the national debt. The idea of relieving the nation of the payment of the enormous taxes which the war has saddled upon us by the sale of the mines in the far distant Pacific

[16] McKinley v. Wheeler, 130 U. S. 630.
[17] Golden Fleece v. Cable, 12 Nev. 312.
[18] 9 U. S. Stats. at Large, 922.
[19] 14 U. S. Stats. at Large, 251.

Slope, about which few people here have any knowledge whatever, was the most popular that was perhaps ever started—compelling other people to liquidate your obligations, has been in all ages and all nations a highly comfortable and popular proceeding. There were some at the time of which I write who would not be satisfied with the sale of the mines. They held that even after the sale the Government should be made a sharer in the proceeds realized from them.

"The first bill on the subject was introduced in the Senate by Mr. Sherman of Ohio and in the House by Mr. Julian of Indiana. Both of these bills contain the most odious features. Sherman's bill went to the Committee on Public Lands, of which Mr. Stewart is a member. After much consideration it was understood that the committee would report adversely. Julian's bill received a much more favorable consideration in the House. In fact, the House went so far as to pass a resolution indorsing legislation substantially of the character contemplated in Julian's bill. After much canvassing, Mr. Conness and Mr. Stewart came to the conclusion that it was no longer safe to act on the defensive, and that it was necessary to determine what legislation would be acceptable, and to make a bold move to obtain it. The Secretary of the Treasury was then one of the strongest advocates of the sale of the mines, and appeared to be under the impression that it would yield a large revenue. The movement thus far had been encouraged by him, and it was thought that a partial success of his views would be more satisfactory to him than entire defeat. Mr. Conness accordingly suggested to him to have a bill prepared in his department, which would avoid the odious provisions of the other two propositions, and get some Senator to introduce it, assuring him that a liberal measure would receive the favorable consideration of the Pacific delegation. The result was that the Secretary had prepared the second bill, introduced by Mr. Sherman, which was a great gain on the first bill. This bill went to the Committee on Mines, of which Mr. Conness was Chairman and Mr. Stewart a member. After much discussion, these two Senators were appointed a committee to draft a substitute, which, after several weeks of close study, resulted in the reporting of a bill substantially the same as the one which is now the law. At this time it was not expected that it would be possible to do more than to get a report of the committee in favor of the measure, which it was thought would be an advanced affirmative position, from which the granting, selling, or other calamitous disposition of the mines could be successfully withstood. Upon making the report, however, it was determined to put on the boldest front possible, and try and pass it through the Senate. It came up on the eighteenth day of June, 1866, and at first had but two warm advocates—its authors. The discussion occupied the entire day, Mr. Stewart supporting the bill. Mr. McDougall first favored the bill, and then made a speech against it. Mr. Williams of Oregon was opposed to all bills of the kind. Nesmith contented himself with voting against it. Nye opposed it and said it would be good policy to let the whole subject alone, and not legislate upon it at all. This speech left his real position somewhat indefinite. In the course of the debate, however, it became manifest, from the remarks of Senators Sherman, Buckalew, and Hendricks, that the real merits of the bill were beginning to be appreciated by the Senate. The two authors of the bill congratulated themselves on this sign of progress, and resolved to try again.

that "all valuable mineral deposits" in lands belonging to the United States, both surveyed and unsurveyed, "are free and open to exploration and *purchase*, and the lands in which they are found, to occupation and purchase." This language, it will be seen, is of broader import than that of the first section of the Act of 1866. It defined a "lode claim." It allowed surface of 1,500 feet by 600 feet, whether located by one or more persons. It imposed no limitation as to locating by same person on the same lode in separate location. It recognized the local customs or rules of miners so far as the same were applicable and not inconsistent with the laws of the United States, and provided that the miners of each mining district may make rules and regulations, not in conflict with the laws of the United States, or of the State or Territory in which the district is situated, governing the location, manner of locating, amount of work necessary to hold possession of a mining claim, subject to the requirements of distinctly marking the location on the ground, so that its boundaries can be readily traced; and that all records of mining claims thereafter made should contain the name or names of the locators, the date of the location, and such a description of the claim or claims located by reference to some natural object or permanent monument as would identify the claim. It provided that the end lines of each claim should be parallel with each other. It granted exclusive right of possession and enjoyment to all lodes, the top or apex of which lay inside the surface lines of the location, with the right to follow the same beyond the side lines and within the end lines of the claim located, to any depth. It provided how tunnel rights might be secured, and how much annual work was necessary on each claim located prior or subsequent to the Act; and that where claims were held in common, such work could be done upon any one claim. It further provided that when a co-owner failed to contribute his proportion of the expenditures required by this Act, how his interest in the claim should become the property of his co-owners who had made such expenditure. It declared the conditions upon which a patent might be obtained, and provided that adverse claims should be determined by proceedings in a Court of competent jurisdiction. It provided, as did the Act of 1866, that as a further condition of sale, in the absence of necessary legislation by Congress, the local Legislature of any State or Territory may provide rules for working mines, involving easements, drainage, and other necessary means to their complete development, and those conditions shall be expressed in the patent.

On the eleventh day of February, 1875, Congress passed an Act amending the then existing law "so that where a person or company has or may run a tunnel for the purpose of developing a lode or lodes owned by said person or company, the money so expended in said tunnel shall be taken and considered as expended on said lode or lodes."[25] The Act was made retroactive, and exempted the owners from the performance of work upon the surface of the lode.

The foregoing several Acts of Congress were codified as Title XXXII, Chapter VI of the Revised Statutes of the United States, 1878, embracing Sections 2319 to 2346, inclusive.

On January 22, 1880, Congress passed an Act declaring that the period within which work is required to be done on all unpatented

[25] 18 U. S. Stats. at Large, 315.

mineral claims located since May 10, 1872, should commence on the first day of January succeeding date of location.

On March 3, 1881, Congress passed an Act declaring that if in any action brought pursuant to Section 2326 of the Revised Statutes (which prescribe the method of determining adverse claims), title to the ground shall not be established by either party, the jury shall so find, and the claimant shall not proceed in the Land Office or be entitled to a patent until he shall have perfected his title.[26]

The intended scope of this article does not include a reference to the statutes of the various States and Territories enacted in relation to working, draining, and preservation of mines, the transfer and mortgage of mining rights, and kindred subjects. They will be found in the statutes and the various treatises upon mining law.

It may be well, however, to call attention to an Act of the Legislature of California of March 31, 1891.[27] It is therein provided that when a mine owner has performed the labor and made the improvements necessary for the location and ownership of mining claims or lodes, he should, within thirty days, file with the Recorder of the county within which the property is situated an affidavit describing the labor performed and the improvement made, and the value; and failure to do such work renders the mine open to relocation. It makes provision, however, for saving the rights of locators who shall return to work before a relocation and continue the same with reasonable diligence. Also, when a person runs a tunnel in good faith for the purpose of developing a lode or claim, the money so expended shall be considered as expended on said lode or claim; provided, that such lode or claim shall be distinctly marked on the surface, as required by law. It also declared that mining claims shall be subject to a right of way for the purpose of working other mines; provided, that damage be assessed and paid for as in land taken for public use. The Act is not the best specimen of lucid expression, but perhaps the intention can be ascertained without much difficulty.

Another Act of a State Legislature, interesting to the people of Montana, but not within the purview of this article, was the Act of the Legislature of that State of March 5, 1891, creating a Mineral Land Commissioner, whose duty is "to prepare and publish a clear and concise statement of the facts in respect to the danger of millions of acres of the best gold, silver, and copper-bearing mineral lands of Montana becoming the property of the Northern Pacific Railroad Company."[28]

The opportunities that mines have afforded for the acquisition of wealth have been provocative of much sharp litigation as to the ownership of mining property. The result has been that nearly every term used in the mining laws has received judicial interpretation and definition.

WHAT IS A MINING CLAIM?

A "mining claim," as the term is used in the statutes of the United States, is that portion of a vein or lode and of the adjoining surface, or of the surface and subjacent material, to which a claimant has acquired the right of possession by virtue of a compliance with the laws of the

[26] 21 U. S. Stats. at Large, 505.
[27] Stats. Cal., 1891, 219.
[28] Stats. Mont., 1891, 178.

United States and the local rules and customs of miners, and must contain at least one known vein or lode; but the vein or lode is not the whole claim. It includes the exclusive right and enjoyment of all the surface within the lines of location.[1]

Independent of Acts of Congress providing a mode for the acquisition of title to the mineral lands of the United States, the term "mining claim" has always been applied to a portion of such lands to which the right of exclusive possession and enjoyment, by a private person or persons, has been asserted by actual occupation, or by compliance with local mining laws, or rules, usages, or customs; but, says the Supreme Court of California: "The mere fact that portions of the land contain particles of gold or veins of gold-bearing quartz rock would not necessarily impress it with the character of 'mineral land' within the meaning of the Acts of Congress of July 1, 1862, and July 2, 1864, giving alternate sections to the Pacific Railroad, but reserving from the grant mineral lands. It must at least be shown that the land contains metals in quantities sufficient to render it available and valuable for mining purposes. Any narrower construction would operate to reserve from the uses of agriculture large tracts of land which are practically useless for any other purpose, and we cannot think this was the intention of Congress."[2]

A miner's claim may include as many locations as he can purchase and the ground covered by all will constitute what he claims for mining purposes, or, in other words, will constitute his mining claim, and be so designated. Care should be taken not to confound the terms "location" and "mining claim" as meaning one and the same thing, when in fact they often mean very different things. A mining claim is a parcel of land containing precious metals in its soil or rock. A location is the act of appropriating such parcel, according to certain established rules.[3]

The use of the words "mines or mining claims" is evidently intended to distinguish between the cases in which the miner is the owner of the soil, and therefore has perfect title to the mine, but works the mine under what is well known in the mining districts, and what is recognized by the Act of Congress as a mining claim.[4]

The words "mining ground," when used in a deed, have a technical meaning. They refer to that interest which a mere occupant of the mine has in the same. They are not the words used when a fee simple title or leasehold interest in real estate is to be conveyed.[5] The term "mining ground" includes the ditches used appurtenant thereto.[6] There is included in the term "mining ground" the vein specifically located, all the surface ground located on each side of it, and all other veins or lodes having their apex inside the surface lines.[7]

WHAT IS A VEIN OR LODE?

It is difficult to define and lay down in so many words the exact meaning of the terms "vein," "lode," or "ledge," which are employed in the statute interchangeably and are nearly synonymous.[1] By the

[1] Mt. Diablo v. Callison, 5 Sawy. 539.
[2] Alford v. Barnum, 45 Cal. 482.
[3] Smelting Co. v. Kemp, 104 U. S. 649; Williams v. Mining Assn., 66 Cal. 198.
[4] Forbes v. Gracey, 98 U. S. 762.
[5] Hale & Norcross v. Storey Co., 1 Nev. 104.
[6] McShane v. Carter, 80 Cal. 310.
[7] Mt. Diablo v. Callison, *supra*.
[1] Iron Co. v. Cheesman, 116 U. S. 530.

term "veins" or "lodes" as used in the Acts of Congress is meant lines or aggregations of metal embodied in quartz or other rock in place. The terms are found together in the statutes, and both are intended to indicate the presence of metal in the rock. Yet *a lode may and often does contain more than one vein.*[2]

A broad metalliferous zone, having within its limits true fissure veins, plainly bounded, cannot be regarded as a single "vein" or "lode," although such zone may have boundaries of its own which can be traced.[3] It is difficult to give any definition of the term, as understood and used in the Acts of Congress, which will not be subject to criticism. A fissure in the earth's crust, an opening in its rocks and strata made by some force of nature, in which the mineral is deposited, would seem to be essential to a lode, in the judgment of geologists. But to the practical miner, the fissure and its walls are only of importance as indicating the boundaries within which he may look for and reasonably expect to find the ore he seeks. A continuous body of mineralized rock lying within any other well-defined boundaries on the earth's surface and under it, would equally constitute, in his eyes, a lode.

The term as used in the Acts of Congress is applicable to any zone or belt of mineralized rock lying within boundaries clearly separating it from the neighboring rock. It includes all deposits of mineral matter found through a mineralized zone or belt coming from the same source, impressed with the same forms, and appearing to have been created by the same processes.[4] This definition, expressed in other words, is that a "lode" designates any zone or belt of mineralized rock lying within boundaries clearly separating it from the neighboring rock. It further implies a oneness, genetically, of the ore deposits included within its boundaries. The definition of a lode given by geologists is that of a fissure in the earth's crust filled with mineral matter, or more accurately, as aggregations of mineral matter containing ore in fissures. (See Van Cotta's Treatise on Ore Deposits, Prime's translation, 26.) But miners used the terms before geologists attempted to give it a definition.[5]

In the books and among miners, veins and lodes are invested with many characteristics, as that they lie in fissures or other openings in the country rock; that they contain materials differing or in some respects corresponding with the country rock; that they are of tabular form and a banded structure; that some one or several things are generally associated with the valuable ores; that they have selvages and slickensides in the fissures and openings, and the like. Some of these characteristics are said to be common to all lodes and veins, and others are of rare occurrence.[6] A vein or lode is a seam or fissure in the earth's crust filled with quartz or with some other kind of rock in place, carrying gold, silver, or other valuable mineral deposits named in the statute.[7] It is a fissure or seam in the country rock filled with quartz matter bearing gold and silver.[8] A body of mineral or mineral-bearing rock in the general mass of the mountains, so far as it may continue

[2] U. S. v. Iron Co., 128 U. S. 679.
[3] Mt. Diablo v. Callison, 5 Sawy. 539.
[4] Eureka Case, 4 Sawy. 302.
[5] Eureka Case, *supra*.
[6] Hyman v. Wheeler, 29 Fed. Rep. 347.
[7] North Noonday v. Orient, 6 Sawy. 308.
[8] Foote v. National, etc., 2 Mont. 404.

unbroken and without interruption, may be regarded as a lode, whatever the boundaries may be. In the existence of such a body, and to the extent of it, boundaries are implied. On the other hand, with well-defined boundaries, very slight evidence of ore within such boundaries will prove the existence of a lode. Such boundaries constitute a fissure, and if in such a fissure ore is found, although at considerable intervals and in small quantities, it is called a lode or vein.[9] An impregnation to the extent to which it may be traced as a body of ore, is as fully within the broad terms of the Act of Congress as any other form of deposit.[10] Whether it is thin or very thick is immaterial, so it is continuous;[11] it may be irregular in thickness, and it may be rich or poor provided it contains a trace of any of the metals named in the statute.[12] In a very recent case the Supreme Court of California says: "A single small vein is weighed and measured by the same law and entitled to the same consideration as the Mother Lode, and very often is far more valuable in the eyes of the miner."[13] A vein is by no means always a straight line or of uniform dip or thickness, or richness of mineral matter throughout its course. The cleft or fissure in which a vein is found may be narrowed or widened in its course, and even closed for a few feet, and then found farther on, and the mineral deposit may be diminished or totally suspended for a short distance, but if found again in the same course with the same mineral within that distance its identity may be presumed; and ore bodies formed off from and connected with a fissure vein do not form a separate vein, ledge, or mineral deposit. A vein or lode must be continuous only in the sense that it can be traced through the surrounding rocks.[14] A vein or lode, as distinguished from a placer claim, includes aggregations of metal imbedded in quartz or other rock in place.[15] The word "lode" is properly defined, says the Supreme Court of California, as a "zone or belt of mineralized rock lying within boundaries clearly separating it from the neighboring rock," and does not apply to gravel deposits inclosed in defined boundaries.[16] Strata lying along the plane of contact between blue and brown limestone, if mineralized to the extent of showing valuable minerals, and distinguishable from other parts of the country rock by carrying ore, and by association with the plane of contact, may constitute a mineralized zone. "Such a zone," says Judge Hallett, "is clearly a lode within the meaning of the law."[17] A vein or lode must be something more than detached pieces or bunches of quartz.[18] Where mineral deposits are separated into three well-defined parts, traceable for a great distance in their length and depth, and having distinct foot and hanging walls, each part is a separate vein within the meaning of the mining laws giving the right to follow the dip of a vein beyond the side lines, although there are many ore-bearing cracks and seams running out from each vein, and sometimes extending over to the other.[19]

[9] Iron Co. v. Cheesman, *supra;* Iron S. M. Co. v. Mike & Starr, 143 U. S. 394.
[10] Hyman v. Wheeler, *supra.*
[11] Iron Co. v. Cheesman, 2 McCrary, 196.
[12] Jupiter v. Bodie, 11 F. R. 666.
[13] Stinchfield v. Gillis, 96 Cal. 33.
[14] Iron Co. v. Cheesman, *supra;* Tombstone Co. v. Way Up Co., 1 Ariz. 426; Cheesman v. Shreve, 40 F. R. 787.
[15] U. S. v. Iron Co., *supra.*
[16] Gregory v. Pershbaker, 71 Cal. 109.
[17] Hyman v. Wheeler, *supra.*
[18] Jupiter v. Bodie, *supra.*
[19] Doe v. Waterloo, 54 F. R. 935.

The distinction between "lode" and "vein" was recently aptly explained by John Hays Hammond, the eminent mining engineer, in his testimony in a mining suit in Idaho; an epitome of it is as follows:

"There is more or less ambiguity in the use of the terms 'veins,' 'lodes,' and 'ledges.' In the statutes these terms are used interchangeably, the object clearly being to give them a more comprehensive meaning than the technical definitions convey. Dana described veins as fillings of cracks or fissures, and divides them into: first, dikes, or those that have been filled by an eruption of melted rock; second, true veins, or those that have been filled by other methods. Dikes should not, I think, be included in the classification of veins, as the filling of dikes is a rock and not a mineral. Webster defines a vein as a 'seam or layer of any substance, more or less wide, intersecting a rock or stratum, and not corresponding with the stratification; often limited in the language of miners to such a layer or course of metal or ore.' This definition is open to the objection that it excludes veins known as 'bed' veins, which follow the strike and dip of the strata in which they are included. The Germans recognize veins of this character as 'lager gange.' These bed veins (lager gange) occupy a previously existing fissure, which, while following the planes of stratification, are nevertheless true fissures in their origin. We make a distinction, however, between 'bed' veins and 'true' fissure veins, the true fissure veins being such veins as cut across the stratification when the country rock is of a stratified character.

"Webster's definition of a lode is: 'A metallic vein, or any regular vein or course, whether metallic or not, but commonly a metallic vein.' This definition is not by any means sufficiently comprehensive. Preferable to the foregoing definitions are those of Van Cotta, who defines veins as 'aggregations of mineral matter in fissures of rock,' and lodes as 'aggregations of mineral matter containing ores in fissures.' He bases the distinction between a lode and a vein upon the presence or absence of ores. In this country no such distinction obtains. While veins may not contain ores, they do contain minerals, such as quartz, calcspar, etc. The best definition of a lode is that given by Judge Field in his Eureka-Richmond decision, which is: 'A zone or belt of mineralized rock lying within boundaries clearly separating it from the neighboring rock. It includes all deposits of mineral matter found through a mineralized zone or belt, coming from the same source, impressed with the same forms, and appearing to have been created by the same processes.' This definition was made with especial reference to the Eureka-Richmond ore bodies, but that deposit is by no means *sui generis*, and the term lode has become extensively used in the classification of ore deposits that are not comprehended by the definition of a vein. A lode as defined by Judge Field is not necessarily a fissure vein, but a lode may contain several fissure veins. Popularly, such an ore occurrence is called a 'broad lode.' Dr. Raymond, an eminent authority, says that a lode is some formation in which the miner could find ore, and out of which he could not expect to find ore. Among practical miners generally narrow veins are designated simply as 'veins,' while veins of great thickness are called 'lodes.' This distinction, of course, is not scientific."

The term "rock in place" has always received a liberal construction. The term does not mean merely hard rock, merely quartz rock; but any

combination of rock, broken up, mixed up with minerals and other things, is rock in place within the meaning of the statute.[20]

A vein or lode cannot be in place unless it is within the general mass of the mountain. It must be inclosed by or held within the general mass of fixed and immovable rock. It is not enough to find the vein or lode lying on the top of fixed or immovable rock, for that which is on top is not within, and that which is without the rock in place cannot be said to be within it, and the mineral must be in place within definite boundaries. If the rock above the lode is in its original position, although somewhat broken and shattered by the movement of the country or other causes, it is in place.[21] Neighboring rock is the non-mineral rock lying next to a lode or vein of mineral rock, being called, in the miner's language, "country" or "country rock."[22]

AS TO WHO MAY ACQUIRE TITLE TO MINING CLAIMS FROM THE GOVERNMENT.

Any citizen of the United States, or one who has declared his intention to become such, may make a mining location. This, by the decision of the Courts, includes minors,[1] females,[2] and corporations.[3] It has been held, however, that when the location is made by a corporation, all of its stockholders at the time of such location must be citizens of the United States.[4] The oath of one of several locators is *prima facie* evidence of the citizenship of all the locators.[5] The statute makes it not only admissible in the Land Office for the purpose of entitling the locator to a patent, but to the litigation of all claims arising under its act, as well in the Courts as in the Land Department.[6] A foreign born son becomes a citizen by the naturalization of his father during the son's minority.[7] An alien, upon declaring his intention of becoming a citizen, may have the advantage of work previously done, and of a record previously made by him, in locating a mining claim on the public mineral lands.[8]

A location by an alien who has not declared his intention to become a citizen shall be maintained until the Government avoids it.[9]

The rights of purchasers from an alien locator, when no adverse interests have been acquired, will be sustained.[10] But the Supreme Court of Nevada held that an alien who has never declared his intention to become a citizen is not a qualified locator of mining ground, and he cannot hold a mining claim, either by actual possession or by location, against one who connects himself with the Government title by compliance with the mining law. Where the first claimant who takes up the claim is not a citizen, or has forfeited his rights by non-compliance with the mining laws, or abandons his claim, the mining ground staked off by him is open to location by any citizen of the United

[20] Stevens v. Williams, 1 McCrary, 480.
[21] Leadville v. Fitzgerald, 4 Morr. M. R. 380.
[22] King v. Amy, 9 Mont. 543.

[1] Thompson v. Spray, 72 Cal. 528.
[2] Thompson v. Spray, *supra*.
[3] North Noonday v. Orient, 6 Sawy. 299; McKinley v. Wheeler, 130 U. S. 630.
[4] McKinley v. Wheeler, *supra*.
[5] Hammer v. Garfield, 130 U. S. 291.
[6] North Noonday v. Orient, *supra*.
[7] North Noonday v. Orient, *supra*.
[8] Crœsus v. Colorado, 19 F. R. 78.
[9] Sever v. Gregovich, 16 Nev. 325; Billings v. Aspen, 52 F. R. 250.
[10] North Noonday v. Orient, *supra*.

States.[11] But the United States Circuit Court of Appeals has recently decided that an alien who has expended time, money, and labor in exploring for and locating a mining claim on public lands, conjointly with others, may hold his interest, or recover the same if deprived thereof, as against his co-locators, and as against all the world, except the United States, though Rev. Stats., Section 2319, confines the right of exploration, purchase, and occupation of unsurveyed mining lands to citizens of the United States, or persons who have declared their intention to become citizens, and that the question whether an alien can inherit an interest in a mining claim located upon Government lands is determined, not by the Federal law, but by laws of the State in which the mine is situated; and under Acts Colo. November 4, 1861, and April 2, 1887, aliens may inherit mining claims located in that State.[12] And one who asserts title to a mining claim under a location made by an alien and two citizens cannot defeat the claims of the alien's heirs on the ground that, under Rev. Stats., Section 2319, an alien cannot be a locator; for mining rights constitute no exception to the general rule that the right to defeat a title on the ground of alienage is reserved to the Government alone.[13] And the Supreme Court of California has held that an alien's declaration of intention to become a citizen must precede his mining location, to render it valid.[14] When several persons perform all the acts necessary to make a valid location, some of whom are aliens and others are citizens, and the location embraces no more than the citizens were entitled to take, such citizens can acquire a title, under such location, to the whole.[15] Prior to the Act of Congress of March 3, 1887, known as the "Alien Act," there was nothing in the laws of the United States prohibiting aliens from holding and working mining ground under a lease from one qualified and who had made a proper location of such mining ground.[16]

We now proceed to trace the course necessary to pursue to acquire title to a mining claim, from the initiatory step to its conveyance by the Government.

It is an indispensable prerequisite to acquiring any rights to a quartz lode mining claim that a discovery shall have been made of the vein or lode sought to be located. The vein is discovered when there is disclosed a well-defined body of rock in place carrying gold, which body afterward proves to be continuous.[17] To constitute a discovery, "rock in place," a well-defined crevice, or at least one well-defined wall or side of the lode, must be found.[18] It is not sufficient to find mineral, which would yield something in a fragmentary condition, in the slide or loose stuff on the surface of the mountain, but the locator must find it within rocks in the general mass of the mountain.[19]

No valid location of a mining claim can be made until a vein or deposit of gold, silver, or metalliferous ore or rock in place has been

[11] Golden Fleece v. Cable Co., 12 Nev. 312.
[12] Billings v. Aspen, 51 F. R. 338.
[13] Billings v. Aspen, 52 F. R. 250.
[14] Anthony v. Jillson, 83 Cal. 296.
[15] North Noonday v. Orient, *supra*.
[16] Ah Kle v. McLean, 32 P. R. 200.
[17] Golden Terra v. Mahler, 4 Morr. M. R. 390.
[18] 15 Am. and Eng. Enc. of Law, 531 and cases cited.
[19] Argentine v. Terrible, 112 U. S. 478.

discovered.[20] A location before an actual discovery confers no right upon the locator.[21] But if after such location a vein or lode is discovered within the limits of the claim located *before* any other party has acquired any right therein, from the date of his discovery would be good, to the limits of his claim, and the location valid.[22] The proper interpretation of the Acts of Congress is that a location must be made by taking up a piece of land to include the vein.[23] And the location should be made in conformity with the strike of the vein; but the law does not require the claim, in order to be valid, to be located along the course of the vein,[24] which is the direction of the vein across and through the country,[25] and a location so laid that its greatest length crosses a vein will secure only so much of the vein as it actually crosses at the surface.[26]

The most practicable rule is to regard the course of the vein as that which is indicated by surface outcrop, or surface exploration and workings. It is on this line that claims will naturally be laid, whatever be the character of the surface, whether level or inclined.[27] A location will be presumed to include the vein upon which the discovery was made, till the contrary be shown.[28] But the mere posting of a notice on a ridge of rocks cropping out of the earth or on other ground, that the poster had located thereon a mining claim, without any discovery or knowledge on his part of the existence of metal there or in its immediate vicinity, would be justly treated as a mere speculative proceeding, and would not itself initiate any right.[29]

By a proper location, a prior inchoate right to obtain a title becomes established, and actual possession is not requisite to maintain such right prior to the issuance of patent.[30] But a location made without prior right of entry on the ground is void. Location confers no right of entry, where such right did not previously exist;[31] and, when perfected, it has the effect of a grant by the United States of the right of present and exclusive possession, and it may be the subject of bargain and sale, and may be sold, transferred, mortgaged, and inherited.[32] The location involves a compliance with the laws of Congress, and with State law and local miners' rules when not inconsistent with the Federal law; and priority of location gives the better title.[33]

If the location covers more than is allowed by law or by the local laws of the mining district, the whole is not thereby rendered void, but the excess may be rejected and the claim held good for the remainder, and a locator of a mining claim may abandon a portion of his original location without forfeiting any rights he may have to the balance of the claim; but where a person who has located a mining claim permits an adjoining occupant to patent that part of his claim on which is located

[20] Overman v. Corcoran, 15 Nev. 147.
[21] Jupiter v. Bodie, 11 F. R. 660.
[22] North Noonday v. Orient, *supra; Compare* Upton vs. Larkin, 7 Mont. 449.
[23] Gleeson v. Martin White, 13 Nev. 442.
[24] Armstrong v. Lower, 6 Colo. 393; Watervale v. Leach, 33 P. R. 418.
[25] King v. Amy, 9 Mont. 543.
[26] Flagstaff Case, 98 U. S. 463; Watervale v. Leach, *supra.*
[27] Flagstaff Case, *supra.*
[28] Patterson v. Hitchcock, 3 Colo. 533.
[29] Erhardt v. Boaro, 113 U. S. 533; Waterloo v. Doe, 55 F. R. 585.
[30] Wolverton v. Nichols, 119 U. S. 485.
[31] Aurora Hill v. 85 Mg. Co., 34 F. R. 515; Belk v. Meagher, 104 U. S. 279.
[32] Forbes v. Gracey, 98 U. S. 94.
[33] Van Zandt v. Argentine, 8 F. R. 725.

his discovery shaft, the remaining portion thereof reverts to the condition of public lands, and is relocatable; and such rule applies, though the patentee made his location after such person.[34]

Discovery and appropriation are the source of title to mining claims, and development by working is the condition of their continued possession until patent is obtained; and as the title comes from appropriation made in accordance with the mining laws, rules, and customs, it is not necessary that a party should personally act in taking up a claim, or in doing the acts necessary to give evidence of the appropriation or to perfect the location. Such acts as these are valid to give title to the claimant, if done by any one for him, or with his assent or approval.[35] The locator must take measures to inform the world that he has appropriated a certain portion of the public mineral lands, and of the extent and boundaries of the portion so appropriated. This is done by taking the following steps: He must distinctly mark the location on the ground, so that its boundaries can be readily traced.[36] This, unless modified or extended by State law or local rules, can be done by the placing of a monument or stake on the center or lode line, upon which is placed a notice in writing describing the length and breadth of the claim.[37]

This method of location can be followed safely only in the absence of State law and local regulations, notwithstanding that the mining Act of Congress does not require a mining claim to be marked by monuments on the ground until the time of its survey for patent.[38] When they exist it is provided generally that the center line shall be marked by three stakes or monuments—one at the center, and one at each end—upon the center one of which is placed the location notice, and upon each center end line a notice stating the direction of the lode with reference to the points of the compass, and declaring the stake or monument to be the limit stake or monument of the lode in the direction mentioned in the notice upon it; as, to illustrate, the east and west end line of the lode. It also generally gives the name by which the lode is to be called. In addition to the foregoing a stake or monument is placed at each corner of the surface of the claim, designating which corner it is with reference to the points of the compass, and also containing the name of the claim. The Federal law does not prescribe the form, shape, or size of a monument or stake, but where monuments or stakes are relied upon to control courses and distances, they must be found as called for; hence, if the location notice calls for a post or stake, a monument of rock will not answer the call.[39]

The validity of a location cannot be made to depend upon the *number* of monuments erected to mark its boundaries, nor upon the length of time it takes to erect them. The location would be just as valid whether it required five minutes or five hours for the work, provided that when completed the boundaries of the location could be readily

[34] Richmond v. Rose, 114 U. S. 576; Tyler v. Sweeny, 54 F. R. 284; Miller v. Girard, 33 P. R. 69.

[35] O'Reilly v. Campbell, 116 U. S. 418; Jennison v. Kirk, 98 U. S. 453; Jackson v. Roby, 109 U. S. 440; Gore v. McBrayer, 18 Cal. 383.

[36] U. S. Rev. Stats., Sec. 2324.

[37] North Noonday v. Orient, *supra;* Jupiter v. Bodie, *supra;* Gleeson v. Martin White, *supra;* Carter v. Bacigalupi, 83 Cal. 187; Gregory v. Pershbaker, 73 Cal. 120; Erhardt v. Boaro, *supra;* Marshall v. Harney Peak, 47 N. W. 290; Doe v. Waterloo, 55 F. R. 11.

[38] U. S. Rev. Stats., Sec. 2325.

[39] Pollard v. Shively, 5 Colo. 309.

traced. The marking must be such that the boundaries of the claim or location can be readily traced, and the question must always be whether or not from the objects placed by the locator the boundaries can be readily traced. One monument, properly marked, may serve that purpose, while seven monuments may be insufficient. What will constitute a valid marking of the location must always largely depend upon the conformation of the particular ground located, and compliance with a statute or local rule or custom requiring the placing of a certain number of monuments at certain points of the location within a certain time is necessary as one of the acts constituting a valid location of a mining claim within the jurisdiction, but it is not sufficient under the Federal law, unless the location is thereby so marked that its boundaries can be readily traced.

In *Gleeson* v. *Martin White, post*, Judge Beatty says: "One of the imperative requirements of the statute, an indispensable condition precedent to a valid location, is that it shall be distinctly marked on the ground, so that its boundaries can be readily traced. * * * *We do not understand that the law requires the surface claim to be defined immediately upon the discovery of the vein.* * * * And it does not appear to be a necessary consequence that the least admissible marking is by posts or monuments at all the corners of the claim. * * * The vein is always the principal object that the locator has in view; * * it is the first thing that attracts the attention of mining men. The surface claim by which it is located ought to conform to its course. * * *So that, if the center line of the claim is once established*, the boundaries are thereby fixed, and may be readily traced. * * * It must be remembered that the law does not in express terms require the *boundaries* to be marked. It requires the *location* to be so marked that its boundaries can be readily traced. Stakes at the corners do not mark the boundaries; they are only means by which the boundaries may be traced. Why not, then, allow the same efficacy to the marking of a center line. * * * If the grand object of the law is attained by the marking of a center line, why should it not be allowed to be sufficient? * * * A mining claim consists of a certain breadth of surface, to be laid off on each side of the line of the croppings, with the mineral deposits included therein. The center line, as a matter of course, is to be a straight line conforming to the general strike of the vein, as nearly as that can be ascertained. The side lines are to be parallel to the center line; and if, as we assume to be the proper construction of the law, the end lines must be parallel and conform to the dip of the vein, which is at right angles to its strike, it follows, with the conclusiveness of a mathematical demonstration, that when the center line is once definitely fixed the boundary lines can be traced (that is, followed out) with absolute certainty. It may be that they could not be traced as easily and readily as if stakes were set at the corners, but the difference would be very slight and of no practical consequence. * * * The whole object of the law is accomplished whenever, from the monuments on the ground, the boundaries of a mining claim can be traced with absolute certainty and without any practical difficulty, and for that purpose a definitely fixed center line is sufficient."

Where there is any doubt as to the true course of the vein, the marking of the boundaries should be postponed as long as possible until the

true course can be ascertained by explorations.[40] In the absence of any local regulation prescribing the time to be allowed for such purpose, the question, What is a reasonable time? would have to be determined by the circumstances of each case. In a recent case it was held that in the absence of State statutes or mining rules fixing the time within which the exterior boundaries should be marked, twenty days was a reasonable time. And as long as the locator exercises good faith and reasonable diligence the Courts will protect him.[41]

To hold that the miner, as soon as he discovers a lode, must immediately stake the territory which he is entitled to claim thereon, in order to protect it from the invasion and claim of others learning of his find, would be an unreasonable, if not an impossible, requirement.[42]

One who has indicated by his acts his intention to perfect a location under the mining laws and statutes should be held, by proper application of the doctrine of relation, to have first marked the boundaries of the claim (in legal effect) as against one who, for the purpose of depriving him of the benefit of his work or of his discovery of mineral of value, shall intervene and mark the boundaries before the first occupant shall have completed or *even commenced* their alignment.[43]

The mining law allows the miners to provide for the recording of claims, and no doubt it was the intention of Congress that such record should have some practical effect, such as, for instance, to hold the claim for a reasonable time, until the vein could be so developed as to admit of an intelligent marking of the surface boundaries.[44]

A notice is generally, and for safety ought always to be, posted immediately upon the discovery of the vein, before there is any time to survey the ground and ascertain the bearing and distance of natural objects or permanent monuments in the neighborhood; and, besides, the claim referred to by the notice is always sufficiently identified by the fact that it is posted on, or in immediate proximity to, the croppings. A notice claiming a location on "this vein" has only one meaning. But the notice is exposed to the danger of removal by adverse claimants, or destruction by the elements; and for the permanent evidence of the location its record is provided for. The record, if it consisted of a mere copy of the notice, would not identify the claim. It was on this account that the *record* (not the notice) was required to contain "such a description of the claim or claims located by reference to some natural object or permanent monument as will identify the claim" (R. S., 2324). It is a sufficient compliance with this provision of the law, if the description of the *locus* of the claim is appended to the notice when it is recorded.[45]

It is always indispensable when a record is made, that the claim shall be located with reference to some natural object or permanent monument, by reference to which the claim can be identified,[46] and without such description a recorded certificate of location is void.[47] The reference to natural objects and permanent monuments is for the purpose of identi-

[40] Iron Co. v. Elgin Co., 118 U. S. 196.
[41] Gleeson v. Martin White, *supra;* Doe v. Waterloo, *supra;* Burke v. McDonald, 33 P.R. 50.
[42] Omar v. Soper, 11 Colo. 380.
[43] Gregory v. Pershbaker, 73 Cal. 120.
[44] Golden Fleece v. Cable, *supra.*
[45] Gleeson v. Martin White, *supra.*
[46] U. S. Rev. Stats., Sec. 2324; Dillon v. Bayless, 11 Mont. 171.
[47] Faxon v. Barnard, 4 F. R. 702; Gilpin v. Drake, 8 Colo. 586.

fying the claim. It is, among other purposes, to show the prospector that the ground he may desire to appropriate has been taken by another. Now, if such prospector reads his predecessor's notice, finds his monuments, and tracing the description finds nothing described, is that notice to him? Is it a description which enables the Government to grant such locator anything certain? We think not. A permanent monument, with no intelligible reference to it, would not describe or identify the claim.[48] In some States the location must be perfected by the sinking of a shaft and such other acts as the law or local rules require. In fact, the safe location of a mining claim requires an observance of the law and local customs, of which one cannot be assured except by a careful study of the same. An attempt to refer to them all would unnecessarily extend this article. The Federal law makes the necessity for recording a mining claim depend upon local rules, or State or Territorial law, in the absence of which it is not necessary, and even where such a custom prevails, the fact that the notice is recorded before it is posted does not render it invalid.[49] But where a local custom requires posting before recording, it is binding.[50] The notice to be recorded is not necessarily identical with that placed upon the claim.[51]

When a notice is required by local law to be of record, it must contain not only a reference to some natural object or permanent monument, as before said, but also the name of the locator or locators, and the date of the location,[52] and its effect is determined by the local laws or regulations.[53] To make the record of a mining claim complete, it must be recorded where the local rules or State law require.[54] An unauthorized location of a mining claim in the name of a third person, by one assuming to act as his agent, may be ratified by the former.[55]

RELOCATION.

Any person may enter upon and locate mineral land which has become forfeited or abandoned.[1] Abandonment is a voluntary act.[2] Forfeiture rests entirely upon the fact of observance or non-observance of the requirements of the statutes or of mining rules and regulations.[3] Mere failure to do work, while it may cause a forfeiture, does not constitute an abandonment.[4] A subsequent location is usually called a "relocation," and is made in the same manner and subject to the same conditions as an original location. Where a notice states that it is a relocation of a certain claim therein named, it is an implied admission of the validity of the original location, and an assertion that the relocator claims a forfeiture by reason of a failure on the part of the original locator to make his annual expenditures.[5]

A relocation made before the default of the owner is a nullity, and

[48] Dillon v. Bayless, *supra.*
[49] Thompson v. Spray, *supra.*
[50] Gregory v. Pershbaker, *supra.*
[51] Gleeson v. Martin White, *supra.*
[52] U. S. Rev. Stats., 2324.
[53] Fuller v. Harris, 29 F. R. 818.
[54] Jupiter vs. Bodie, *supra.*
[55] Thompson v. Spray, *supra;* Rush v. French, 1 Ariz. 99; Murle v. Ennis, 2 Colo. 300

[1] Carter v. Bacigalupi, 83 Cal. 187.
[2] Larkin v. Sierra Buttes, 25 F. R. 337.
[3] Storey v. Ryan, 46 Cal. 33; King v. Edwards, 1 Mont. 235.
[4] Larkin v. Sierra Buttes, *supra.*
[5] Willis v. Blain, 20 P. R. 978.

does not become valid upon the first locator's subsequent default. Hence, a relocation on lands actually covered at the time by another valid and subsisting location is void, and this not only against the prior locator, but all the world, because the law allows no such thing to be done.[6]

A relocation may be made under proper circumstances, by the original locator, and it does not act as an abandonment of the first location,[7] even though other names are added as co-locators.[8] So, also, by the vendee of an alien. If the claim originally informally located is subsequently relocated by the same person according to law, his title dates back by relation to the first location.[9]

It is doubtful if entry by stealth, at 1 o'clock of a New Year's morning, can be the basis of a valid relocation.[10]

An amended location is not, strictly speaking, a relocation, though sometimes called so. When the rights of third parties are not interfered with, the boundaries and a record of a mining location may be changed at the pleasure of the owner, subject only to the provisions of the State or local laws.[11]

The United States Circuit Court says, in reference to the State law of Colorado, specifically providing for amended certificates:

"Errors and mistakes in certificates of location are of frequent occurrence. Under the law as it is at present, a fully complete and unimpeachable certificate cannot be made without the aid of a surveyor and the best instruments. It is often, and perhaps generally, impracticable to obtain the services of a surveyor in making a location, and the miner must depend upon his own skill and judgment. In such effort he usually fails. Indeed, it may be said as to the course of his lines he is always in error, and the natural object and permanent monument required by Section 2324 of the United States Revised Statutes are entirely beyond his grasp. He does not know what they are, nor how to refer to them. Every one who is at all familiar with mining locations knows that in practice the first record must usually, if not always be imperfect. Recognizing these difficulties, it has never been the policy of the law to avoid a location for defects in the record, but rather to give the locator an opportunity to correct his record whenever defects may be found in it. The local laws usually provide for the amending of certificates of location." [12]

REQUIREMENTS AS TO ANNUAL EXPENDITURES.

Having ascertained how to acquire an inchoate title to a mining claim, we will now consider what to do to maintain it, and what steps are necessary to preserve the acquired right until patent is issued.

On each claim located after the tenth day of May, 1872, $100 worth of work must be performed or improvement made each year until the issuance of the patent.[1] This applies to placer as well as to lode locations.[2]

[6] Belk v. Meagher, 104 U. S. 279.
[7] Fuller v. Harris, 29 F. R. 818.
[8] Weill v. Lucerne, 11 Nev. 201.
[9] Fuller v. Harris, *supra*.
[10] Pharis v. Muldoon, 75 Cal. 284.
[11] Crœsus v. Colorado, 19 F. R. 78.
[12] McEvoy v. Hyman, 25 F. R. 596.
[1] U. S. Rev. Stats., Sec. 2324.
[2] Carney v. Arizona, 65 Cal. 40.

It is not difficult, in looking at the policy of the Government in regard to its mineral lands, to understand the purpose of this provision. For many years after the discovery of the rich deposits of gold and silver in the public lands of the United States, millions of dollars' worth of these metals were taken out by industrious miners without any notice or attention on the part of the Government. The earliest legislation by Congress simply recognized the obligatory force of the local rules in each mining locality in regard to obtaining, transferring, and identifying the possession of these parties. Later, provision was made for acquiring title to the land where these deposits were found, and prescribing rules for the location and identification of claims, and securing their possession against trespass by others than their discoverers. But in all this legislation to the present time, though by appropriate proceedings and the payment of a very small sum a legal title in the form of a patent may be obtained for such mines, the possession under a claim established according to law is fully recognized by the Act of Congress, and the patent adds little to the security in *continuous* possession of a mine he has discovered or bought.

These mineral lands being thus open to the occupation of all discoverers, one of the first necessities of a mining neighborhood was to make rules by which this right of occupation should be governed among themselves; and it was soon discovered that the same person would mark out many claims of discovery, and then leave them for an indefinite length of time without further development and without actual possession, and seek in this manner to prevent others from availing themselves of the abandoned mine. To remedy this evil a mining regulation was adopted that some work should be done on each claim in every year, or it would be considered as abandoned. Congress, when it came to regulate these matters and provide for granting a title to claimants, adopted the prevalent rules as to claims asserted prior to the statute, and as to those afterwards it required $100 worth of labor or improvements to be made in each year on every claim. Clearly the purpose was the same as in the matter of similar regulations by the miners, namely, to require every person who asserted an exclusive right to his discovery or claim to expend something of labor or value on it as evidence of his good faith, and to show that he was not acting on the principle of the dog in the manger.[3]

Work may be done on the claim itself anywhere upon its surface within the surface lines, or anywhere below the surface within those lines extended downward vertically;[4] or on other ground, when it has a direct relation and is in reasonable proximity to it.[5] Where several locations are held as a mining claim, work done upon any one of the locations, equaling in amount that which would be required on all the locations, if they were separate or independent, is sufficient to maintain the acquired right to each location, but the locations must be contiguous, so that each location thus associated will be in some way benefited by the work done on one of them. To fulfill the requirements of the law, the work done must have a direct bearing upon either the

[3] Chambers v. Harrington, 111 U. S. 350.
[4] Mount Diablo v. Callison, 5 Sawy. 439.
[5] Smelting Co. v. Kemp, 104 U. S. 655; Jackson v. Roby, 109 U. S. 440; Chambers v. Harrington, *supra*; Hall v. Kearny, 33 P. R. 373.
[6] Mt. Diablo v. Callison, *supra;* Jackson v. Roby, *supra;* Chambers v. Harrington, *supra*.

present or future improvement or working of the mine itself;[7] and if done for the purpose of discovering mineral, whatever the particular form or character of the deposit which is the object of search, it is within the spirit of the statute.[8] The work may be performed by the original locators, or their heirs, assigns, or legal representatives.[9] The law fixes no time within the year when the work must be done. The period within which the annual work is required to be done commences on the first day of January succeeding the location,[10] and expenditures made or labor performed prior to the first day of January succeeding the date of location, cannot be applied on the first annual expenditure. If the locator, or his heirs or assigns, after the time for the expenditure has elapsed, but before third parties' right have intervened, resume work, and continue till the necessary amount is expended, their right is revived, and relates back to the original location.[11] Under the late statute of California before referred to, provision is attempted to be made for furnishing evidence that the labor or improvements required by law have been duly performed. It consists in filing with the Recorder of Deeds for the county in which the property is situated, within thirty days after the time limited for the performance of the labor or making the improvements, an affidavit describing the labor performed and improvements made, and the value of the same. Upon the failure of any co-owners to contribute his or their share of the expenditures required, those who have performed the labor or made the improvements, at the expiration of the year, may give the delinquent notice in writing, or by publication in a newspaper once a week for ninety days, and if, after the expiration of that time, the delinquent fail to contribute his or their portion, their interests become the property of those who have performed the requirements of the statute. One seeking to perfect a title to a mining claim in California should acquaint himself with the provisions of the Act.[12] The provision of the above statute of California as to a co-owner obtaining the interest of his delinquent co-owner, is a copy of the Federal statute upon that subject.

APPLICATION TO THE U. S. SURVEYOR-GENERAL FOR A SURVEY OF THE CLAIM.

There is no time prescribed within which a mine owner shall apply for a patent.[1] He may make the application himself or by a duly accredited agent, for an official survey of the premises sought to be patented. The application usually contains the name of the deputy surveyor desired by the applicant to make the survey. The application must be accompanied by a certified copy of the notice of location, if the same appears of record; if not, secondary evidence of the applicant's title will be received; and by evidence of the deposit in the Sub-Treasury of the United States of the fees required for the office work in

[7] Bryan v. McCaig, 10 Colo. 309; Du Prat v. James, 65 Cal. 555; Moxon v. Wilkinson, 2 Mont. 421; Remington v. Baudit, 6 Mont. 138.
[8] U. S. v. Iron Co., 24 F. R. 568.
[9] U. S. Rev. Stats., Sec. 2324.
[10] Belk v. Meagher, 104 U. S. 279; U. S. Rev. Stats., Sec. 2324.
[11] Pharis v. Muldoon, 75 Cal. 284; Belcher v. Deferrari, 62 Cal. 160; U. S. Rev. Stats., Sec. 2324.
[12] Stats. Cal. 1891, 219.
[1] Wolfley v. Lebannon, 4 Colo. 112.

the Surveyor-General's office. It has been held that the survey is the act of the claimant and not the act of the Government, and that the deputy acts under the direction of the claimant.[2]

Briefly, we may say that the deputy's duties are to survey the located premises and make a plat thereof, indorsed with his approval, designating the number and description of the location, the value of the labor and improvements, and the character of the vein exposed.

After the deputy has made the survey and sent such data to the Surveyor-General as is required by him, two copies of the plat and a copy of the field notes are sent to the applicant. A diagram showing the location of the claim within the section is sent by the Surveyor-General to the General Land Office, and he also forwards a copy of the plat furnished the applicant for patent to the local Land Office. The original returns of the deputy are kept in the office of the Surveyor-General. The Federal law provides that $500 worth of labor or improvements shall have been expended or made by the claimant or his grantors upon the claim prior to the expiration of the sixty days' period of newspaper publication of the intention to apply for a patent. It is immaterial at what time prior to that the labor is performed or improvements made. The essential thing is that evidence of such fact be furnished within the statutory period to the local Land Office.

The proceedings to obtain patent for a consolidated claim are the same as when the claim covers but one location.[3]

PROCEEDINGS IN THE LOCAL LAND OFFICE.

The proceedings in the local Land Office are initiated by the filing of an application, under oath, of the claimant or his or its agent, thereunto duly authorized, showing a compliance with the requirements of the law. This is accompanied by a copy of the plat and field notes given by the Surveyor-General to the claimant, an abstract of title of the claimant, or in case the locator is the applicant, a certified copy of the notice of location takes the place of the abstract, or in the event that the records have been destroyed an affidavit of the claimant, supported by those of any other parties cognizant of the facts relative to his location, occupancy, and possession, etc., should be filed with the application. The proceedings necessary to be had when the statute of limitations is the basis of the applicant's rights are set out under the head of The Statute of Limitations, *post*. If the applicant be a natural person, evidence of his citizenship must be given by his affidavit; if a corporation, a certified copy of its articles of incorporation proves its citizenship. The application will not be received by the Register of the Land Office unless there is therewith presented the affidavit of two witnesses to the prior posting on the claim of a copy of the plat, together with a notice of intention to apply for a patent. Thereafter the Register orders publication for sixty days, of the intention to apply for a patent, in a newspaper published nearest to the claim. Where newspapers are published equal distances from the claim, the Register determines in which one the notice shall be published. During the period of publication the plat and notice must remain posted on the

[2] Wolfley v. Lebannon, *supra*.
[3] Smelting Co. v. Kemp, 104 U. S. 636.

claim, and during the same period the Register must keep a copy of the notice of intention to apply for a patent posted in his office. The Register is responsible for defects in the published notice. Upon the expiration of the sixty days' newspaper notice (which is process bringing all adverse claimants into Court[1]), in case no adverse claim has been filed, the applicant becomes entitled to a patent without further action on his part, other than the payment of $5 per acre and fraction thereof embraced in the claim, and the filing in the local Land Office of an affidavit of the continued posting on the claim of the plat and notice of intention to apply for a patent, during the sixty days of newspaper publication, the affidavit of the publisher of the newspaper publishing said application, and the agreement of the publisher to look only to the applicant for his advertising bill, a sworn statement of the fees and charges paid by him to the Surveyor-General, the local Land Office, the Deputy Surveyor, the newspaper publishing the notice, and the amount paid for the land. He must also file a certificate from the County Clerk, and another from the Clerk of the Federal Court, that no suit is pending affecting the title to the property. Upon the performance of these acts the Receiver issues to the claimant a final receipt. The Receiver then sends all the papers mentioned, together with the certificate of posting of notice in the local Land Office, etc., to the General Land Office. After the applicant for patent has obtained his final receipt, or certificate of purchase, he is not obliged to continue the annual expenditure upon the claim required by the mining Act, pending final decision on his application and issuance of patent,[2] because, says the United States Supreme Court, "When the price is paid the right to a patent immediately arises. If not issued at once, it is because the magnitude of the business of the Land Department causes delay. But such a delay, in the mere administration of affairs, does not diminish the rights flowing from the purchase, or cast any additional burdens on the purchaser, or expose him to the assaults of third parties."[3]

The proceeding is in the nature of a proceeding *in rem*, and is binding upon all the world, so far as any unrepresented claim is concerned.[4]

But the provisions in Rev. Stats., Secs. 2325–26, as to adverse claims to a lode to which a patent is asked, do not apply to a person who, before the publication first required, had himself gone through all the regular proceedings required to obtain a patent for mineral land from the United States, had established his right to the land claimed by him, and had received his patent therefor.[5]

PROCEEDINGS IN CASE AN ADVERSE CLAIM IS FILED.

Adverse and opposing claimants must file their claims against the mining claim sought to be patented, within the sixty days' period of newspaper publication, or it is conclusively presumed that the applicant is entitled to a patent.[1] The fact that when the notice is published in a weekly newspaper the full term of publication is sixty-three

[1] Wight v. Du Bois, 21 F. R. 693.
[2] Aurora Hill v. 85 Mining Company, 34 F. R. 515.
[3] Benson v. Alta, 145 U. S. 428.
[4] Hamilton v. Mining Co., 33 F. R. 562.
[5] Iron S. M. Co. v. Campbell, 135 U. S. 286.
[1] U. S. R. S., Sec. 2325-26; Wight v. Du Bois, 21 F. R. 693; Dahl v. Raunheim, 132 U. S. 262.

days, does not extend the time in which to file adverse claims in the local Land Office.

Under the law the first step of a party desiring to file an adverse claim is to employ a deputy mineral surveyor to make a survey, which will show the adverse claimant's entire claim, its relative position or situation with the one against which he claims, and the extent of the conflict. From this survey a plat is made by the deputy, showing the boundaries and extent of the adverse claim and the approximate value of the labor performed or improvements made thereon by the adverse party or his predecessors in interest, and the plat must indicate the position of any shafts, tunnels, or other improvements, if any such exist upon the claim of the party opposing the application for patent, and by which party such improvements were made. This plat must be certified or sworn to by the deputy making it.

The adverse claim must be upon the oath of the party making it, his agent or attorney in fact, and in the case of a corporation, some one of its officers is usually authorized to prosecute the proceedings in the Land Office, and must show the nature, boundaries, and extent of such claim,[2] and must be accompanied by said plat, an abstract of title, if held under mesne conveyances, or a location notice, if made by one who claims to be a locator, and evidence of citizenship. An adverse claimant must be able to establish by proof all the prerequisites necessary to be established in the case of an original claimant, in order to prevail against the applicant for a patent.[3] In order to keep an adverse claim alive, proceedings must be commenced in a Court of competent jurisdiction to determine the question of the right of possession and to determine who has the better right to obtain the patent.[4] The proceedings must be commenced within thirty days from filing the adverse claim, and be prosecuted with reasonable diligence to final judgment.[5] What constitutes the commencement of an action in a State Court is a matter of State law.[6] The filing of an adverse claim does not arrest the publication of notice or the filing of the affidavit of such publication.[7] All other proceedings in the local Land Office are stayed until the final determination of the questions litigated in the Court, or the adverse claim is waived. Waiver may be evidenced by a filing in the records of the Court by the plaintiff, of a plea that he abandons his case or waives his claim, or by an instrument signed by the contestant, and duly authenticated, that he had sold his interest to the other party, or had abandoned his claim and his contest,[8] or by failure to prosecute the case with reasonable diligence, or by failure to appear at the trial. Undoubtedly the parties can lawfully agree at any stage of the proceedings that the patent may issue to the applicant, and that he shall deed the ground in conflict, in whole or in part, to the contestant.

The prevailing party in the Court files in the local Land Office a certified copy of the judgment roll, together with the certificate of the Surveyor-General that the requisite amount of labor has been expended or

[2] U. S. R. S., Sec. 2325–26.
[3] Gwillim v. Donnellan, 115 U. S. 45.
[4] Gwillim v. Donnellan, *supra;* Iron Co. v. Campbell, 135 U. S. 297.
[5] Gwillim v. Donnellan, *supra;* Richmond v. Rose, 114 U. S. 576.
[6] Richmond v. Rose, *supra.*
[7] U. S. R. S., Sec. 2326.
[8] U. S. R. S., Sec. 2326.

improvements made upon the claim, or such portion thereof as the decision of the Court shows him entitled to, and the description required in other cases, and pays the same fees and amounts as are required of an original claimant in the absence of an adverse claim.[9]

The Register certifies to the General Land Office the whole proceedings and the judgment roll. Upon the reception at the General Land Office of the judgment roll, etc., patent issues in conformity with the judgment of the Court. In case there are several parties whose rights in the claim are established by the result of the litigation, each of which is segregated from the rights of the others, then a patent is to be issued to each of the parties according to their respective rights.[10]

It is not clear why the law requires that an adverse claim filed in the local Land Office is to be made with such particularity as to detail, as its office is merely to stay all proceedings until the controversy it inaugurates shall have been settled or determined by a Court of competent jurisdiction, or the adverse claim waived. If the Court decides for one party or the other, the Land Department is bound by the decision. If it decides that neither party has established a right to the mine, or any part of it, this is equally binding as the case then stands. With all this these officers have no right to interfere. After the decision they are governed by it. Before the decision, once the proceeding is initiated, their function is suspended, and they have no further act of judgment to exercise.[11]

If a certified copy of the adverse claim could be filed in the Courts as the commencement of proceedings between the applicant and the adverse claimant, to determine who has the better right to obtain the patent, its value would be apparent. As it is, it serves no purpose that a simple notice in writing substantially setting forth the ground of the adverse claimant's alleged rights would not effect, and thus a present great and useless expense would be obviated.

The discussion so far has been in relation to those who claimed an interest or some right in the mining property. It may happen, however, and sometimes does happen, that a protest is filed against the issuance of a patent, by a party claiming no interest in the mining claim itself. It must be filed in the local Land Office, and is cognizable only there,[12] and may be filed at any time before the patent is issued. The ground of such protest may be non-citizenship of the applicant, or in a general way it may be said to be fraud or lack of good faith on the part of the claimant in regard to any of the essential requisites to entitle him or it to a patent.

PROCEEDINGS IN THE GENERAL LAND OFFICE.

After all the foregoing proceedings have been had, and the claim is pending in the General Land Office, that office has the power to suspend, disaffirm, or cancel the final receipt issued to the applicant,[1] order republication and a reposting on the claim and in the local Land Office (if this is done it subjects the applicant to the interposition of any

[9] U. S. R. S., Sec. 2326; Iron Co. v. Campbell, *supra.*
[10] U. S. R. S., Sec. 2326.
[11] Richmond v. Rose, *supra.*
[12] Wight v. Du Bois, 21 F. R. 693.
[1] Deffeback v. Hawke, 115 U. S. 392.

adverse claim existing at the time of the original publication and posting and not presented in due time), call for additional evidence or more complete information of the applicant's rights and proceedings in presenting his claim. It also has the power to eliminate from a claim so much thereof as may have been included in a prior patent. Also to withdraw a patent which has not been delivered.[2]

The power of supervision possessed by the Commissioner of the General Land Office over the acts of the Register and Receiver of the local Land Offices, in the disposition of the public lands, undoubtedly authorizes him to correct and annul entries of land allowed by them, where the lands are not subject to entry, or the parties do not possess the qualifications required. The existence of this power is necessary to the due administration of the Land Department. If an investigation of the validity of such entries were required in the Courts of law before they could be canceled, the necessary delays attending the examination would greatly impair, if not destroy, the efficiency of the Land Department. But the power of supervision and correction is not an unlimited nor an arbitrary power. It can be exerted only when the entry was made upon false testimony or without authority of law. It cannot be exercised so as to deprive any person of land lawfully entered and paid for.[3]

An appeal lies from a decision of the Commissioner of the General Land Office to the Secretary of the Interior, and the decision of the Secretary finally rendered concludes the department.[4] In other words, while the issuance of a patent is pending, the General Land Office has plenary power over the subject, but when once the patent is issued its power or control over the subject ceases, and the only way in which the title can be impeached is by a bill in chancery.[5]

AS TO THE FINAL RECEIPT OR CERTIFICATE OF PURCHASE.

An applicant for a patent for a mining claim, who has made final entry, paid the purchase money for the land embraced in the survey, and obtained his certificate of purchase, is not obliged to continue the annual expenditure on the claim required by Section 2324, U. S. Rev. Stats., pending final decision on the application and issuance of patent.[1]

An entry and certificate of purchase, say the Courts, so long as they remain uncanceled, are equivalent to a patent, so far as the rights of third parties are concerned;[2] the certificate of purchase duly issued cannot be collaterally assailed;[3] it must still be borne in mind that the entry may be canceled or disaffirmed by the officers of the Land Department.[4] For example, for fraud or material error, the officers of the Land Department may order republication and reposting of the notice of intention to apply for a patent, on the ground that by such fraud or error the rights of adverse claimants may have been prejudiced or

[2] Maguire v. Taylor, 8 Wall. 650.
[3] Cornelius v. Kessel, 128 U. S. 456.
[4] Moore v. Robbins, 96 U. S. 530.
[5] Iron Co. v. Campbell, 135 U. S. 286.

[1] Benson v. Alta, 145 U. S. 428; Aurora Hill v. 85 Mg. Co., 34 F. R. 515; Deno v. Griffin 20 Nev. 249.
[2] Stark v. Storrs, 6 Wall. 402; Aurora Hill v. 85 Mg. Co., *supra*; Deffeback v. Hawke 115 U. S. 405.
[3] Hamilton v. Southern Nevada, 33 F. R. 562.
[4] Deffeback v. Hawke, *supra;* McTarnahan v. Pike, 91 Cal. 540.

jeopardized. Such republication and reposting reopens the matter, and any adverse claimant who may not have presented his adverse claim within the former period of publication and posting, may take advantage of such action and assert his adverse claim in the Land Office and in a Court of competent jurisdiction. Assume that the party named in the final receipt or certificate of purchase was a person qualified to locate and obtain patent for a mining claim. That between the time of the issuance of such receipt and the order of republication and reposting, he has transferred this particular mining claim to an alien. The entryman has received a valuable consideration for the transfer, his interests have wholly ceased and determined, and the claimant's right stands of record in the alien. Can the latter defend the action of an adverse claimant? The plaintiff must recover on the strength of his own title and not the weakness of that of his adversary; but the defendant must show his right as against the Government as well as against the plaintiff,[5] and if it appears in such an action that neither had acquired such rights, judgment should be given against both.[6]

In the suppositious case under discussion the alien has become the transferee of the rights of the holder of the certificate of purchase, which have been suspended and his right thereto become the subject of judicial determination, and it would seem that, upon proof of the alienage of the defendant, the Court must, as between the parties, award to the plaintiff the ground in controversy without further proof as to the rights of the plaintiff. This would not necessarily end the case, however, as the plaintiff must still prove his case against the Government, as the object of the action is not only intended to determine the rights of the two parties as *between themselves, but also between such of the parties and the United States*, so as to determine finally whether *either* party has so far performed the conditions prescribed by the statute, and is of a character capable of entitling him to pay for the mine and receive a patent from the United States.[7] In other words, the certificate of purchase raises no guaranty of ownership, and it is doubtful if one who has parted with his entire interest in a claim could successfully defend an action in relation thereto, in behalf of an alien. If the reopening of the application as outlined practically places the applicant for patent again on the defensive, is not the alien transferee put in the same position as if the property had not been entered in the Land Office, and is he not thus made subject to all of the disabilities of an alien locator upon a portion of the public domain, notwithstanding that a final receipt or certificate of purchase is held by the Supreme Court of the United States as the equivalent of a patent? It may be interesting to note under this point that the Supreme Court of California has held that a *bona fide* resident of that State, though not a citizen of the United States, or having declared his intention to become such, may, by *conveyance*, acquire and hold the title of the locators of an unpatented mining claim acquired under Sections 2319 and 2322 of the United States Revised Statutes, and has a full and complete right to convey the same.[8]

It has been held by the Supreme Court of California, under the

[5] Anthony v. Jillson, 83 Cal. 296; Gwillim v. Donnellan, 115 U. S. 45.
[6] Jackson v. Roby, 109 U. S. 440.
[7] Burke v. Bunker Hill, 46 F. R. 644.
[8] Ferguson v. Nevills, 61 Cal. 386.

authority of Section 1925 of the Code of Civil Procedure, that the certificate of purchase is *prima facie* evidence of ownership, which may be overcome by proof that at the time of the location of the land upon which the certificate issued the land was in the adverse possession of another party, and that proof of adverse possession is quite sufficient to overcome the evidence offered by plaintiff's certificate of purchase.[9] If this decision be law it nullifies the provisions of the Mining Act of Congress, that "if no adverse claim shall have been filed with the Register and Receiver of the proper Land Office at the expiration of the sixty days of publication, *it shall be assumed that the applicant is entitled to patent*, * * * and that no adverse claim exists, and thereafter no objection from third parties shall be heard, except it be shown that the applicant has failed to comply with this Act."[10]

No final receipt or certificate of purchase can issue, pending the determination of an adverse claim, which must be presented in the manner, form, and time hereinbefore shown, or it shall be deemed waived. If the defendant in the case under consideration had "adverse possession" he should have protected his right by a compliance with the Federal law; failing to do this it would seem, under the terms of the law itself and the construction it has received by the Federal Courts, that his legal rights had been lost by his own negligence, and that the certificate of purchase was as unassailable on the ground of his adverse right as the patent itself would be. The patent is evidence of a perfected right in the patentee to the claim conveyed.[11] It is conclusive as to all rights which could have been asserted in the proceedings.[12]

The patent of the United States is the conveyance by which the nation passes its title to portions of the public domain. For the transfer of that title the law has made numerous provisions designating the persons who may acquire it, and the terms of its acquisition. That the provisions may be properly carried out, a Land Department, as part of the administrative and executive branch of the Government, has been created to supervise all the various proceedings taken to obtain title, from their commencement to their close. In the course of their duty the officers of that department are constantly called upon to hear testimony as to matters presented for their consideration, and to pass upon its competency, credibility, and weight. In that respect they exercise a judicial function, and therefore it has been held in various instances by the Supreme Court of the United States, that their judgment as to matters of fact, properly determinable by them, is conclusive when brought to notice in a collateral proceeding. Their judgment in such cases is like that of other special tribunals upon matters within their exclusive jurisdiction, unassailable except by direct proceeding for its correction or amendment. The execution and record of the patent are the final acts of the officers of the Government for the transfer of its title; and as they can be legally performed only after certain steps have been taken, that instrument duly signed and sealed not only operates to pass the title, but is in the nature of an official declaration by that branch of the Government to which the alienation of the public land

[9] McTarnahan v. Pike, *supra*.
[10] Dahl v. Raunheim, 130 U. S. 260.
[11] Eureka Case, 4 Sawy. 317.
[12] Richmond v. Rose, 114 U. S. 584; Steel v. Smelting Co., 106 Id. 447; Smelting Co. v. Kemp, 104 Id. 636.

under the law is instituted, that all the requirements preliminary to its issue have been complied with. The presumptions thus attending it are not open to rebuttal in an action at law.[13] And the certificate of purchase of mineral land, upon an entry of the same by a claimant at the local Land Office, passes the right of the Government to him, and as against the acquisition of title by any other party is equivalent to a patent. The land thereby ceases to be the subject of sale by the Government, which thereafter holds the legal title in trust for the holder of the certificate.[14]

If the certificate of purchase is equivalent to the patent, it is as conclusive against any claim of adverse possession existing at the time of the location as the patent itself, and the decision of the Supreme Court of California does not seem to be in harmony with the Mining Act and the construction it has received from the Federal tribunals.

However, in a very recent case in Colorado a certificate of purchase had been issued to a citizen who was the grantee of an alien, who deraigned title from an alien locator. This certificate of purchase was issued about one month *after* a citizen had made a *bona fide* location of a conflicting claim, and the question presented to the Supreme Court was: Can an alien acquire such an interest in a mining claim by location as can be transferred to one or more parties by various conveyances, and through such claim so transferred can title be obtained from the Government of the United States, against which a subsequent locator cannot assert a legal right? And the Court say that such title, being based on an invalid location, cannot be supported by authority, reason, or statute. And the Court also said that to prove and establish a right to a patent from the Government of the United States, it was clearly the duty of the party seeking the title under the provisions provided by statute, to prove a valid location and a thorough compliance with the mineral laws. In the absence of such proof the Government officials were not authorized to issue a certificate of purchase or a patent for the land, and the certificate holder took no title against a subsequent *bona fide* locator.[15]

PATENT FOR QUARTZ LODE LOCATIONS.

Although a location perfected under the law is in itself a grant, and is property in the highest sense of that term,[1] until a patent is obtained the fee remains in the United States.[2] The patent is the superior and conclusive evidence of legal title,[3] and no one can maintain an equitable right to any portion of the public land as against the patent, which would not be good against the Government.[4] But equities may exist against the patentee which only an examination of the title from its inception would disclose.[5] The patent vests the patentee with the common law right of ownership from the center of the earth upward to the

[13] Smelting Co. v. Kemp, *supra;* Iron Co. v. Sullivan, 16 F. R. 829.
[14] Deffeback v. Hawke, *supra;* Aurora Hill v. 85 Mg. Co., 34 F. R. 570, and cases cited.
[15] Lee v. Justice, 29 P. R. 1021.

[1] Belk v. Meagher, 104 U. S. 279.
[2] Robertson v. Smith, 1 Mont. 410.
[3] Baynell v. Broderick, 13 Pet. 450; Aurora Hill v. 85 Mg. Co., 34 F. R. 515; Steel v. St. Louis, 106 U. S. 447.
[4] Boggs v. Merced, 14 Cal. 279.
[5] Sussenbach v. Bank, 5 Dak. 477.

sky, and the additional right to follow a vein or lode upon its dip within his side lines under the surface of adjoining territory,[6] provided he has the apex of such vein or lode within his claim, and subject to the same right in behalf of others similarly situated. In other words, the patentee has no greater rights, privileges, or immunities than had a locator on the question of extra lateral rights. In either event he may invade other territory, or have his own invaded when the circumstances warrant, whether both are held by location or patent, or one is patented and the other held by location, and the relative dates of the patents or notices of location are immaterial.[7] But the vein cannot be followed into the lands of an adjoining proprietor who holds an elder title under a patent for agricultural lands.[8] Nor where the claim is in the form of an isosoles triangle can the lode or vein be followed through the side lines.[9]

In several adjudged cases "top" and "apex" have been treated as synonyms. The word "apex" ordinarily designates a point, and so considered the apex of a vein is the summit, the highest point in the vein in the ascent along the line of its dip or downward course, and beyond which the vein extends no farther; so that is the end, or, reversely, the beginning, of the vein. The word "top," while including "apex," may also include a succession of points; that is, a line, so that by the "top" of a vein would be meant the line connecting a succession of such highest points or apices, thus forming an edge.[10] It is not required that it shall be on or near, or within, any given distance of the surface.[11] The apex of a vein is not necessarily a point, but often a line of great length.[12] The owner of the apex under a triangular shaped location cannot follow the lode or vein upon its dip outside of his own territory. The lode outside of such side lines belongs to the United States, and cannot properly be located nor patented under the existing laws. Congress may, by appropriate legislation, provide for the sale of the same,[13] but technically, until such action the working of such ground will constitute a trespass upon the public domain, and render the claimant liable to the Government for the value of the ores so taken.

However, the Supreme Court of California has held that when the northerly line of one patented claim and the southerly line of an other patented claim diverged, leaving a small triangular piece of ground between, the owners of the respective claims had the right, as against a subsequent locator, to agree to divide this piece of land, or rather the right to work the ledge under it, between them.[14]

It often happens that the tops or apex of more than one vein lie within the surface side lines, and the veins may have different courses and dips, yet the locator's right to follow them outside of the surface lines of his location must be bounded by planes drawn vertically through the same end lines. The planes of the end lines cannot be

[6] U. S. R. S., Sec. 2322; Iron Co. v. Elgin Co., 118 U. S. 218.
[7] Colorado Cent. v. Turck, 50 F. R. 888; Cheesman v. Hart, 42 F. R. 98.
[8] Amador v. Spring Hill, 36 F. R. 668.
[9] Montana v. Clark, 42 F. R. 626.
[10] Duggan v. Davey, 26 N. W. 887.
[11] Iron Co. v. Murphy, 3 F. R. 368.
[12] Larkin v. Upton, 144 U. S. 19.
[13] Montana v. Clark, *supra*.
[14] Champion v. Wyoming, 75 Cal. 78.

drawn at a right angle to the courses of all the veins if they are not identical.[15]

When a claim is located along a lode, and its owner's right to follow the dip beyond the lateral lines conflicts with the right of an owner of a claim located across the lode to a portion thereof actually within his lines, the claim having priority of location should prevail.[16]

Where a vein upon which a location rests, after being followed for a considerable distance, forks and passes out through the side line of the location, so that the outcrop of one fork is on an adjoining claim, this whole fork belongs to the owner of the latter claim.

The right of a mine owner, under Rev. Stats., Section 2322, to follow a vein whose apex lies within the boundaries of his claim beyond the vertical side lines thereof and within the lines of other claims, is not confined to cases in which the claim thus entered is held under a junior patent or certificate, and the relative dates of the patents or certificates is immaterial.[17]

When the apex of a vein passes out of the side line of a claim into an adjoining claim, the latter, though junior in date, gives to its owner the right to follow the vein in its dip underneath the senior claim.[18]

In the celebrated "horseshoe case,"[19] Mr. Justice Field says: "The exterior lines of the Stone claim form a curved figure somewhat in the shape of a horseshoe, and its end lines are not and cannot be made parallel. What are designated as end lines are not such." And the Court held that the extra lateral right did not attach to such a location. Mr. Chief Justice Waite dissented from the opinion of the Court, and said: "I cannot agree to this judgment. In my opinion, the end lines of a mining location are to be projected parallel to each other and crosswise of the general course of the vein, within the surface limits of the location, and whenever the top or apex of the vein is found within the surface lines extended vertically downwards, the vein may be followed outside of the vertical side lines. The end lines are not necessarily those which are marked on the map as such, but they may be projected at the extreme points where the apex leaves the location, as marked on the surface." In commenting on this case, in Doe vs. Sanger,[20] Mr. Justice McFarland says that "the objection (of plaintiff) there was not that the end lines of the Stone claim were out of parallel; and as a matter of fact, what were claimed to be the end lines *were* parallel. The objection rested on the general 'form and shape' of the Stone surface location, and on the fact that the disputed ore in the Gilt Edge was not within vertical planes drawn through the end lines of the Stone claim, * * * which is a surface location with nearly a dozen exterior lines, with no distinguishable side lines or end lines, made in extreme violation of the usages and principles of location recognized by the statutes, and which, if it gives any right to follow a vein at all, would give the right to follow veins in nearly a dozen different directions. * * * And it may be noticed that the opinion of the Court was delivered by the same learned Justice who said, in the Eureka case,

[15] Iron Co. v. Elgin Co., *supra*.
[16] Tyler v. Sweeney, 54 F. R. 284.
[17] Colorado Cent. v. Turck, *supra*.
[18] Colorado Cent. v. Turck, 54 F. R. 282.
[19] Iron Co. v. Elgin Co., *supra*.
[20] Doe v. Sanger, 83 Cal. 203.

supra, that the provision about end lines being parallel was only directory."

As the law stands we think that the right to follow the dip of the vein is bounded by the end lines of the claim properly so called, which lines are those which are crosswise of the general course of the vein on the surface. The Spanish mining law confined the owner of a mine to perpendicular lines on every side, but gave him greater or less width according to the dip of the vein. But our laws have attempted to establish a rule by which each claim shall be so many feet of the vein lengthwise of its course to any depth below the surface, although laterally its inclination shall carry it ever so far from a perpendicular.[21]

The Government is the proprietor of all veins or lodes whose top or apex is not within the limits of any grant it has made,[22] and most, if not all, patents for lode mining claims contain a reservation that the Government reserves all minerals whose apex is not within the side lines of the location.

The dip is spoken of from three different points of view:

(1) As to its inclination from a perpendicular or a horizontal as so many degrees from the perpendicular or from the horizontal. A vein is thus described as having a dip of 20°, 38°, etc.

(2) As to the direction it takes from the strike or apex by the points of the compass. If the strike were due east and west, and the vein in its course downward departed from the perpendicular at an angle so that a perpendicular shaft sunk at the apex would leave the vein at the north of such shaft, the dip, in this point of view, would be said to be due north, or, the conditions reversed, due south. In this respect the dip, that is the direction of the dip, is said to be, and is, at right angles to the strike.

(3) The dip is again spoken of as the portions of the vein successively encountered in going down and away from the apex. The miner follows the dip when he works downward, leaving the apex farther from and above him at each advance. He follows the strike when he works lengthwise on the vein on a level; that is, when he is advancing along the vein, neither rising toward the surface of the ground nor descending, but going on a level with the plane of the earth's surface.

The third definition is the practical idea of the miner when he speaks of following his dip.[23]

It is practically the universal custom to measure the dip by its angular deflection from the horizontal, as for example, a dip of 20° means 20° deflection from the horizontal.

The right to follow the dip exists whether the express grant of such right is contained in the patent or not,[24] but it would not seem to attach to one whose claim to mineral land depends only on a railroad title, any more than that the patentee of agricultural land would possess the extra lateral right to a vein discovered within his lands. The Federal statute provides how a claim shall be located in order to secure that right, and it certainly would not issue patent for mineral land unless it was claimed as such; and a patent presupposes a valid location or adverse possession as a mining claim for a period equal to the time prescribed by the

[21] Flagstaff Case, 98 U. S. 463.
[22] Montana v. Clark, *supra*.
[23] King v. Amy, 9 Mont. 543.
[24] Doe v. Waterloo, 54 F. R. 935.

statute of limitations for mining claims in the State or Territory where the same may be situated.

The officers of the Land Department always assume, in proceedings to obtain a patent, that the top or apex of the vein sought to be patented is embraced therein, and after patent issues it is not subject to collateral attack, as upon questions of fact their decisions are conclusive upon all parties. But it may be held, if the question is tested, that in issuing patent for a lode claim not possessing the apex the Land Department did not have jurisdiction to act, and the patent be inoperative to pass the title.[25] It has been intimated that if the location is made on the dip of the vein the locator may pursue it in a downward course, though not in an upward course, and hold the whole which lies within his location and below it, as against any one locating subsequently at a higher point on the same lode.[26] This does not seem to be in harmony with the mining law and the later decisions on the subject.

The dip can only be followed when it is substantially at right angles with the strike.[27] Where the location crosses the vein the side lines are to be considered as the end lines.[28] No rights, however, are lost by a deviation from a paralleling of the end lines in the original location.[29] The patent is conclusive on this point.[30] If it is otherwise, the Government alone can take advantage of the defect.[31]

It was argued at the recent trial of a case in Arizona that, as a matter of fact, lodes, veins, and ledges do not intersect, except upon their strike; that an instance of a crossing upon the dip of two veins was unknown, and that therefore Section 2336, Revised Statutes, must refer to the crossing of lodes on their strike; that Congress would not legislate to define rights dependent upon a condition that can never happen, and the Court said: "If it be true that an instance of two lodes intersecting upon their dip is unknown, that fact is only evidence, and we think very slight evidence, that they may not do so. It is a complete answer to that that lodes can cross on their dip. But we think it unimportant whether they can or not. Congress had in mind, at the time of the enactment of the law of 1872, that, as mining rights then stood, A's lode might legally cross B's lode on the strike, and whether on the dip or not makes no difference; and Section 2336 was designed to define the rights of A and B in the space of intersection. Under the construction of Sections 2322 and 2336 we are, within the plain, unambiguous terms of the statute, giving to every part of it its full meaning and effect. It results in a beautifully simple means of defining mining rights. The construction urged by appellees, and supported by the Equator and subsequent Colorado decisions, violates the language of the statute, injects into it things not there, results in conflict in the statute among its parts, and makes infinitely more complex the old system of lode claims."[32]

The deputy mineral surveyor who makes the official survey of the claim preparatory to patent, is instructed by the Surveyor-General to

[25] Richmond v. Rose, 114 U. S. 576; Silver Bow v. Clark, 5 Mont. 378; Larkin v. Upton, *supra*.
[26] Iron Co. v. Murphy, *supra*
[27] Tombstone v. Way Up, 1 Ariz. 426.
[28] Argentine v. Terrible, 112 U. S. 478; Tombstone v. Way Up, *supra*; Flagstaff Case, *supra*.
[29] Horswell v. Ruiz, 67 Cal. 111; Doe v. Sanger, *supra*; Tyler v. Sweeney, *supra*.
[30] Doe v. Waterloo, *supra*.
[31] Eureka Case, 4 Sawy. 302.
[32] Watervale v. Leech, 33 P. R. 418.

parallel divergent end lines. If, on the coming in of his preliminary plat and field notes, it is discovered that he has omitted to do so, he is compelled to make a resurvey showing his compliance with the instructions sent him by the Surveyor-General. By such rectification the applicant has less ground within his surface lines, and the vertical end lines extended in their own direction (possibly) include less of the ledge than they did before, and cannot prejudice the right of an adjoining claimant on the dip.[33] After patent has issued no annual or other work is required upon the claim; surface boundaries are fixed and determined, and the patentee is free from conflicting claims of title to the surface, but he may be divested of his title by the adverse possession of another, the exercise of eminent domain, and the sale of his property for delinquent taxes; he is still subject to suits for trespass and suits to determine the ownership of or right of way to cross lodes, which latter are excepted from the grant, and the right thereto, except as to the space of intersection, being not lost by failure to adverse.[34]

Although we have said that a patent may be taken as conclusive evidence of the settlement of surface boundaries, the statement must be made with this qualification: The Land Department regulations and the instructions of the Surveyor-General require that the private or mine survey shall be "tied" to the nearest corner of the public or land surveys of the United States. This line is often run by calculation or triangulation, and almost as often discloses the fact of gross error in the distance of the line so calculated from the corner section to the corner of the mine surveyed. In a rough country such error has been known to exceed 1,200 feet. This error, always annoying to the mine owner on discovery, is perhaps more or less immaterial up to a certain point of time. Of course it is usual to "tie" the claim surveyed to mounds and bluffs and other natural objects, and occasionally, also, to more or less distant mining claims. A claim so surveyed and tied is presumably so marked upon the ground by monuments at its corners, such and such distances from the various objects named. So in theory, at least, a retracing of the lines, starting from any one of such objects, will establish the *locus* of the claim as it is monumented. But it is natural to suppose, and it is often the fact, that after lapse of time the surface of the ground in an active mining camp is subject to change; the bluffs and mounds and other objects to which the mine is tied may afterwards be razed by blasting or otherwise, and thus become destroyed; the monuments of the claim to which the one in question is tied may become obliterated; the monuments of the claim itself may be destroyed or obliterated, and to retrace the lines thereof, if the initial point is the corner section of the public surveys, which is, say, 1,200 feet out of the way, where by reference to the patented description will the mine be placed on the resurvey? Where public opinion may place it, or as it is described in the patent.

How would it affect the parties in an action of ejectment or on a question of extra lateral rights if it should be made to appear that the patent described a mining claim which by its connecting line (proved by the oath of a competent surveyor) placed the, let us say, south side line of the claim 50 feet beyond the ledge sought to be patented and left said

[33] Eureka Case, *supra*.
[34] Lee v. Stahl, 9 Colo. 208.

ledge lying between said south side line (as retraced) and the north side line of the claim lying south of the claim patented?

What is to govern, the claim as it is marked upon the ground, or as it described in the patent? If the patent does not describe the claim, what is its value? If the location is as it is marked upon the ground, what is the value of the description in the patent if it is erroneous as showing title to ground which, technically at least, it does not cover? What does the Government convey by its patent, the ground erroneously described in the patent, or the claim as it is (properly) marked upon the ground? The Supreme Court of Colorado has held that in proving identity of a patented mining claim the rule is that monuments will control courses and distances; it is not necessary that the former be unquestionable in order to control the latter, and that it is only after the entire description in a patent has been considered and found so inaccurate as to render the identity of the grant wholly uncertain, that the grant is held void.[35] On the contrary, the Supreme Court of California has held that if a deed described the land conveyed by adopting the corner of a subdivision, according to the United States survey, as a starting point, said corner is a monument, and will control.[36]

Assume that a mine owner, relying upon his patent, does no work on his claim and the claim is relocated by another party, will patented description prevail in action of ejectment when connecting line throws claim off 1,200 feet from the ground sought to be patented? As a fact, must not the patent, like a deed, be construed from the mere words and nothing else?[37]

These questions may not arise, but they are extremely probable, and while they may not occasion trouble in our lifetime, are certainly a heritage of lawsuits for posterity. The connecting line insisted upon by the Government must be for a purpose, and is not that purpose to determine the *locus* of the private survey by making the corner section of the public surveys the initial point in resurveying or retracing the line of such private survey?

The questions propounded are such as have arisen in the mind of the writer, and which he does not assume to answer, as they have not yet been judicially determined. Sufficient has been said to show the caution that should be exercised in avoiding such errors as have been mentioned.

TUNNEL RIGHTS.

Any one running a tunnel for the development of a vein, or for the discovery of mines, shall have the same right of possession of all veins or lodes on the line of such tunnel, within 3,000 feet of the face thereof, which shall be discovered in such tunnel, and which were not previously known to exist, as if the discovery was made from the surface, and he may claim 750 feet of the lode each way from the point of discovery.[1] By regulation of the General Land Office, one desiring to secure a tunnel right is required: "At the time they enter cover, to give proper notice of their tunnel, by erecting a substantial post, board, or monument at the face or point of commencement thereof, upon which should be posted a

[35] Cullacott v. Cash, 8 Colo. 179.
[36] Powers v. Jackson, 50 Cal. 429.
[37] Pollard v. Shively, 5 Colo. 309.
[1] Glacier v. Willis, 127 U. S. 471; U. S. R. S., Sec. 2323; Ellett v. Campbell, 33 P. R. 521.

good and sufficient notice, giving the names of the parties or company claiming the tunnel right, the actual or proposed course or direction of the tunnel, the height and width thereof, and the course or distance from such face or point of commencement to some permanent well-known objects in the vicinity, by which to fix and determine the *locus*, in manner applicable to locations of veins or lodes; and at the time of posting such notice they shall, in order that miners and prospectors may be enabled to determine whether or not they are within the lines of the tunnel, establish the boundary lines thereof, by stakes or monuments placed along such lines at proper intervals, to the terminus of the 3,000 feet from the face or point of commencement of the tunnel, and the lines so marked will define and govern as to the specific boundaries within which prospecting for lodes not previously known to exist is prohibited while work on the tunnel is being prosecuted with reasonable diligence.

"At the time of posting notice and marking out the lines of the tunnel as aforesaid, a full and correct copy of such notice of location defining the tunnel-claim must be filed for record with the mining recorder of the district, to which notice must be attached the sworn statement or declaration of the owners, claimants, or projectors of such tunnel, setting forth the facts in the case, stating the amount expended by themselves and their predecessors in interest in prosecuting work thereon, the extent of the work performed, and that it is *bona fide* their intention to prosecute work on the tunnel so located and described with reasonable diligence for the development of a vein or lode, or for the discovery of mines, or both, as the case may be. This notice of location must be duly recorded, and, with the said sworn statement attached, kept on the recorder's files for future reference."

The face of a tunnel is that point at which it actually enters cover. The line of the tunnel is held to be limited to the actual width as designated by the boundary stakes or monuments.[1] Other parties are not prohibited from prospecting for blind lodes or running tunnels, so long as they keep outside of the "line" as above defined.

The following views of the writer upon tunnel rights are not claimed to be supported by decisions of the Courts, but it is thought are in harmony with other portions of the mining law. The section affecting tunnel rights must be read in connection with the sections affecting lode claims, which provide that the locator of a lode claim shall have the exclusive right of possession and enjoyment of all the surface included within the lines of his location, *and of all veins, lodes, and ledges throughout their entire depth the tops or apex of which lie inside of such surface lines extended downward vertically*, etc. In the opinion of the writer this language negatives the right of way through, or acquirement of blind lodes discovered in, existing locations. Color is lent to this theory by this example: A tunnel location is not patentable; a lode discovered by the tunnel should be located upon the surface of the ground. How could such a location be made if the surface of the ground is already in the rightful possession of another? Again, a patent will not issue for a lode claim without surface ground. Must, then, the discoverer of a blind lode under these circumstances be compelled to keep his rights alive, if any, by annual expenditure alone? Take this instance (as there is no

[1] Corning v. Pell, 4 Colo. 307.

limit to the number of tunnels that may be run as long as they keep outside of their respective lines): What would prevent a party from making a large number of tunnel locations extending through a mining location, the right to which has already become established in the locator, and thus render his location practically valueless? Certainly the law never contemplated such a result. Of course, the question of priority may arise between tunnel owners themselves, as it would in the following instance: A has located and staked his tunnel and is engaged in running it; B commences a tunnel outside of but within 300 feet of the extreme sides of A's tunnel as located and staked, finds a vein and takes ore therefrom. Although B's location is valid, it is liable to be divested by the subsequent discovery of the same vein in A's tunnel.[3]

The right of a tunnel owner is limited to the discovery of veins or lodes not previously known to exist, and it is the view of the writer that such discovery must be made in ground not already appropriated, or in other words, in ground that has not become private property. Upon a tunnel right, no certain amount of work is required, but if work is not prosecuted on the tunnel for a period of six months it shall be considered as an abandonment of the right to all undiscovered veins on the line of such tunnel. Resumption of work on the tunnel after abandonment has occurred will not, in the opinion of the writer, revive the right lost by such abandonment. It is true that some contrariety of opinion has been expressed by writers upon the subject of tunnel rights. In a recent Colorado case upon this subject, it is said by Judge Hallett that "A miner who discovers a lode or vein while driving a tunnel, under the provisions of Rev. St. § 2323, must mark the boundaries of his claim on the surface, and file his certificate of location, but the discovery in the tunnel suffices for the usual work, such as a shaft, adit, or other opening; and the date of such location on the surface will be carried back to the date of locating the tunnel, and will thus shut out intermediate surface locations by others."[4] Subsequently the Colorado State Supreme Court said: "Where one duly locates a tunnel claim under U. S. Rev. St. § 2323, and discovers a mineral lode in the tunnel, he is not bound to make another discovery and location of the lode from the surface in order to be protected against a subsequent surface locator of the same lode."[5] All lodes worked through a tunnel are benefited with respect to the requirements of annual expenditure, in that the money expended and labor performed in the tunnel represents that required upon the lode itself.

A tunnel right is an anomaly in the law, as it can be made the subject of an adverse claim, but not of patent.[6] And, says the Supreme Court of Montana, proceedings for a patent for a mining claim located after the tunnel location and within the surface boundaries thereof, will be restrained while the tunnel claimant is prosecuting his work as required by law, and until it is demonstrated that the vein in the surface location will not be discovered in the tunnel, or until such tunnel rights are abandoned.[7] This opinion was rendered, notwithstanding a

[3] Hope v. Brown, 7 Mont. 550.
[4] Rico Aspen v. Enterprise, 53 Fed. Rep. 321.
[5] Ellett v. Campbell, *supra*.
[6] Black v. Sierra Nevada, 17 P. R. 85.
[7] Hope v. Brown, 11 Mont. 370.

showing by the respondent that it would require *thirty years* to run the full course of the tunnel, if past endeavor was an earnest of future achievement. Although this seems at first glance to work a hardship upon the the junior and lode locator, it must be remembered that he made his location with notice and knowledge of the tunnel locator's pre-existing right, and was therefore in no way prejudiced by having his patent proceedings thus suspended.

MILL SITES.

Non-mineral land, not contiguous to the vein or lode, to the extent of 5 acres, can be appropriated for a mill site by the owner of a vein or lode.[1] The owner of a quartz mill or reduction works not owning a mine in connection therewith, may also acquire such right.[2] The law provides that a mill site may be patented upon proof of its non-mineral character, subject to the same preliminary requirements, as to survey and notice, as are applicable to veins or lodes.[3] It would seem to follow that in acquiring a mill site the same steps should be taken as in locating a lode claim, after its discovery, subject to State or local laws. If the applicant for a mill site is the owner of a vein, the expenditure on such vein obviates the necessity for expenditure on the mill site, otherwise he must expend the amount required on the site itself. A mill site application is subject to adverse claim and all the other incidents of patent proceedings. An applicant for a patent for a mill site on which a lode exists, claimed by other parties, may file an abandonment of the lode claim, and receive a patent for the remaining part of the mill site location. All that is necessary to make the claim of a mill site by the owner of a non-contiguous mining claim valid, is the reasonable use and occupation thereof for mining purposes in connection with a mining claim.[4] But where an application for a mill site patent was not made in good faith by the applicant for himself, it was held that he was not entitled to a patent.[5]

PLACER CLAIMS.

Claims usually called "placers," including all forms of deposit excepting quartz or other rock in place, are subject to entry and patent under like circumstances and conditions, and upon similar proceedings, as are provided for vein or lode claims.[1] But the amount of land which may be taken up as a placer claim, and the amount as a lode claim, and the price per acre to be paid to the Government in the two cases, where patents are obtained, are different. And the rights conferred by the respective patents, and the conditions upon which they are held, are also different.[2] By the term "placer claim" is meant ground within defined boundaries, which contains in its earth, sand or gravel; ground that includes valuable deposits not in place—that is, not fixed in rock—but which are in a loose state, and may, in most cases, be

[1] U. S. R. S., Sec. 2337.
[2] U. S. R. S., Sec. 2337.
[3] U. S. R. S., Sec. 2337.
[4] Hartman v. Smith, 7 Mont. 19.
[5] Hamburg M. Co. v. Stephenson, 17 Nev. 449.
[1] U. S. R. S., Sec. 2329.
[2] v. Iron Co., 128 U. S. 673.

collected by working or amalgamation without milling.[3] A deposit of gold-bearing ground, though it lies between clearly defined strata of rock, is nevertheless a placer and not a lode.[4] The discovery of mineral is not a prerequisite to a placer location.[5] No placer location can exceed 160 acres, and no individual can locate more than 20 acres. No local law or mining regulation can restrict a placer location to less than 20 acres, though the locator may take less. It requires eight persons to take up 160 acres. If a corporation locates a placer claim it is subject to the same limitation as are individuals. There is nothing in the law forbidding one person, or association of persons, purchasing as many separate and distinct locations as desired, and embracing in one application for patent the entire claim.[6] It has been held lately, in California, that a contract between several persons, that they shall locate for their joint benefit an amount of placer mining ground exceeding the legal limit of 20 acres allowed for each of them by Section 2331 of the U. S. Revised Statutes, and that, in making the location, using the names of such additional locators as will voluntarily, and without consideration, convey their interests to the contracting parties jointly, contemplated a fraud upon the Government, and is against public policy, and void.[7]

In locating a placer claim the same necessity seems to exist for posting and recording notices and marking boundaries as in a lode location.[8] The requisites of holding a placer claim and acquiring a patent thereto are the same as in the case of lode locations, with two exceptions:

1. When placer claims are upon surveyed lands, and conform to legal subdivisions, no further survey or plat is required.[9]

2. When a person is in possession of a placer claim which includes one or more lodes or veins, he must, in his application for a patent, state that fact, or the lodes or veins will not be included in his patent; provided, that they are known to exist at the time of such application. The holder of a placer claim cannot dispossess persons in possession of a lode within the boundaries of the placer claim, whether the latter have any title or not, if the lode was known to exist when the placer patent was applied for, and was not included in the application. If they are not known to exist at the time, then the patent for the placer ground will convey all the mineral and other deposits within the boundaries thereof.[10]

It may not be easy to define the words "known to exist," nor has it been determined whether this knowledge must be traced to the applicant for the patent, or whether it is sufficient that it was generally known, nor what kind of evidence is necessary to prove such knowledge.[11] Mere speculation and belief, not based on any discoveries in the placer tract, or any tracings of a vein or lode adjacent thereto, is not knowledge, the possession of which would exclude the vein or lode from being embraced in the patent.[12]

When the applicant is at the time in possession of a vein or lode

[3] U. S. v. Iron Co., 128 U. S. 673.
[4] Gregory v. Pershbaker, 73 Cal. 109.
[5] Gregory v. Pershbaker, 73 Cal. 109.
[6] Smelting Co. v. Kemp, 104 U. S. 636.
[7] Mitchell v. Cline, 84 Cal. 409.
[8] White v. Lee, 78 Cal. 593.
[9] U. S. R. S., Sec. 2331.
[10] Reynolds v. Iron Co., 116 U. S. 687; Reynolds v. Iron Co., 124 U. S. 348.
[11] Reynolds v. Iron Co., *supra*.
[12] Sullivan v. Iron Co., 143 U. S. 431.

included within the boundaries of his placer claim he shall state that fact, and on the payment of the sum required for the vein claim, and 25 feet on each side of it, at $5 per acre, and $2 50 for the remainder of the placer claim, his patent will cover both.[13] A vein or lode is known to exist when it has been duly located, although personal knowledge of the fact may not be possessed by the applicant for a patent of a placer claim.[14] The information the law requires the locator to give to the public must be deemed sufficient to acquaint the applicant with the existence of the vein or lode.[15] The term "known vein" (Rev. Stats. § 2333) refers to a vein or lode whose existence is known as contradistinguished from one which has been appropriated by location, and it cannot be said, as a matter of law in advance, how much of gold and silver must be found in a vein before it will justify exploitation and be properly called a "known vein."[16]

Before a vein or lode can be deemed to fall within those excepted from a placer patent as a known lode existing at the time of the application of the patentee, the lode must be discovered and located so far as capable of measurement.[17] It is not enough that there may have been some indications, by outcroppings on the surface, of the existence of lodes or veins of rock in place, bearing gold or silver or other metal, to justify their designation as "known" veins or lodes. To meet that designation the lodes or veins must be clearly ascertained, and be of such extent as to render the land more valuable on that account, and to justify their exploration.[18] The right to follow the dip of a lode beyond the surface boundaries of a placer claim is confined to lodes which have been directly patented, and therefore it does not apply to a blind lode discovered within the boundaries of a placer claim after such claim has been patented.

HOMESTEADS.

No land is subject to entry as a homestead unless it is subject to preemption,[1] and no lands on which are situated any *known* salines or mines are subject to preëmption.[2]

Sec. 2318, Rev. Stats., provides "that in all cases lands valuable for minerals shall be reserved from sale, except as otherwise expressly directed by law." And although there may be no fraudulent concealment by purchasers of the public land at cash entry, yet if, under the law, the lands were reserved from sale, it is the well-settled rule that purchasers obtain no title by their purchase; the sale is absolutely void.[3]

The nature and extent of the deposit of precious metals which will make a tract of land "mineral," or constitute a "mine" therein, within the meaning of the statute, has not been judicially determined. Attention is called to the question in McLaughlin v. United States (107 U.S. 526), but no opinion is expressed. The Land Department appears to

[13] Reynolds v. Iron Co., *supra*.
[14] Reynolds v. Iron Co., *supra*.
[15] Reynolds v. Iron Co., *supra*.
[16] Iron Co. v. Mike & Starr, 143 U. S. 395.
[17] Sullivan v. Iron Co., *supra*.
[18] U. S. v. Iron Co., 128 U. S. 673.

[1] Rev. Stats., Sec. 2289.
[2] Rev. Stats., Sec. 2258, and see Rev. Stats., Sec. 2302. Rev. Stats., Sec. 2318
[3] U. S. v. Culver, 52 F. R. 81.

have adopted a rule that if the land is worth more for agriculture than for mining, it is not mineral land, although it may contain some measure of silver. "This," says Judge Deady, in United States v. Reid,[4] "is the only practicable rule of decision that can be applied to the subject. Nor can account be taken, in the application of this rule, of profits that would or might result from mining under other and more favorable conditions and circumstances than those which actually exist, or may be produced or expected in the ordinary course of such a pursuit or adventure on the land in question. For instance, it appears that the watershed of Jackson Creek is limited, and the volume of water there is comparatively small. Some of the witnesses are of the opinion that the whole 40 acres might be profitably mined, if an unlimited supply of water could be procured for that purpose. But, in determining the question whether the land is mineral or not, such contingencies, possibilities, or even probabilities cannot be considered. Practically, they are no part of the case.

"The truth is, the mines on and about this ground were practically worked out long since; and the land has no appreciable value, except for agricultural purposes. Occasionally some one who prefers to gamble on the chance of finding a nugget to a fair day's wages for an honest day's work, may be found loitering about the old cabins, and working wistfully among the debris of former washings, in the vain hope of finding an easy living, if not a fortune. I suppose there are thousands of acres of land in southern Oregon and northern California in the same condition, and the sooner it is understood that it is open to the occupation of the farmer, the better it will be for the country. Forty acres of this land, cleared and planted in vegetables, vines, and fruit trees, furnishing a permanent home and sure support for an industrious farmer and his growing family, is worth more to the State, in a social and economic point of view, than all the mining or gold of the creek, twice told. On such foundations, rather than the vagrancy and uncertainty of mining for the precious metals, social order and good government are most surely built and sustained.

"The statute does not reserve any land from entry as a homestead, simply because some one is foolish or visionary enough to claim or work some portion of it as mineral ground, without any reference to the fact of whether there are any paying mines on it or not. Nothing short of *known mines* on the land, capable, under ordinary circumstances, of being worked at a profit, as compared with any gain or profit that may be derived therefrom when entered under the homestead law, is sufficient to prevent such entry. Mere mineral prospect or hope, however pleasing or auspicious, shall not keep the land from the plow or the pruning-hook, and it is well that it does not."

In Davis v. Wiebold,[5] the Supreme Court of the United States says: "If mineral patents will not be issued unless the mineral exist in sufficient quantity to render the land more valuable for mining than for any other purpose, which can only be known by development or exploration, it should follow that the land may be patented for other purposes if that fact does not appear."

In the case of Commissioners of King Co. v. Alexander,[6] Mr. Secre-

[4] U. S. v. Reed, 28 F. R. 482.
[5] Davis v. Wiebold, 139 U. S. 507.
[6] Com. of King Co. v. Alexander, 5 L. D. 126.

tary Lamar said: "It has been repeatedly held by this department that the proof of the mineral character of land must be specific and based upon the actual production of mineral; that it is not enough to show the neighboring or adjoining lands are mineral in character, or that the lands in controversy may hereafter develop minerals as to such an extent as to show its mineral character, but it must be shown as a present fact that the lands are mineral, and this must appear from actual production of mineral and not from a theory that the land may hereafter produce it."

In Royal Placer case,[7] Acting Secretary Chandler said: "The Supreme Court has not determined what amount of gold will constitute a valuable deposit. I judge, as indicated in United States v. Iron Silver Mining Company (128 U. S. 673), that the deposit must be of special value. The suit was brought by the United States to cancel two patents for certain placer mining claims, alleging that they had been obtained by false and fraudulent representations. The Court says: 'It is the policy of the Government to favor the development of mines of gold and silver and other metals, and every facility is offered for that purpose; but it exacts a faithful compliance with the conditions required. There must be a discovery of mineral, and a sufficient exploration of the ground to show this fact beyond question. * * If the land contains gold or other valuable deposits in loose earth, sand, or gravel, it must be *secured with profit;* that fact will satisfy the demand of the Government as to the character of the land as to placer ground.' This view is in line with the repeated rules of the department. In Cutting v. Reininghaus (7 L. D. 265), it was said: 'The mere fact that portions of the land contain particles of gold would not necessarily impress it with the character of mineral land; it must at least appear that it contains metal in such quantities as to make it available and valuable for mining purposes.' That case also adopted the views expressed in Cal. Mining Co. v. Rowen (2 L. D. 719), 'that to constitute mining land, it must be also shown it will pay to mine by the usual mode of mining.' See also Peirano v. Pendola (10 L. D. 536); Searl Placer (11 L. D. 441). From this examination I have concluded that there is no legal necessity for changing the attitude of the department on this question; and that when the issue is made in any case, it must appear as a fact that mineral can be secured with profit. This fact, of course, may be shown by any competent evidence."

In the case of Deffeback v. Hawke,[8] the United States Supreme Court, after stating the provisions of law relative to the sale of mineral land, said: "It is plain from this brief statement of the legislation of Congress, that no title from the United States to land known at the time of sale to be valuable for its minerals of gold, silver, cinnabar, or copper, can be obtained under the preëmption or homestead laws, or the townsite laws, or in any other way, than as prescribed by the laws specially authorizing the sale of such lands. * * * We say 'land known at the time to be valuable for its minerals,' as there are vast tracts of public land in which minerals of different kinds are found, but not in such quantity as to justify expenditures in the effort to extract them. It is not to such lands that the term 'mineral,' in the sense of the statute, is applicable."

[7] Royal K. Placer, 13 L. D. 86.
[8] Deffeback v. Hawke, 115 U. S. 404.

The same Court, in the case of Colorado Coal Company v. United States,[9] quoted from Deffeback v. Hawke, *supra*, and applied the rule enunciated therein to coal lands claimed to be reserved from sale under the preëmption law under the term "known mines." The Court said: "We hold, therefore, that to constitute the exception contemplated by the Preëmption Act under the head of 'known mines,' there should be upon the land ascertained coal deposits of such an extent and value as to make the land more valuable to be worked as a coal mine, under the conditions existing at the time, than for merely agricultural purposes. The circumstance that there are surface indications of the existence of veins of coal does not constitute a mine. It does not even prove that the land will ever be, under any conditions, sufficiently valuable, on account of its coal deposits, to be worked as a mine. A change in the condition occurring subsequently to the sale, whereby new discoveries are made, or by means whereof it may become profitable to work the veins as mines, cannot affect the title as it passed at the time of the sale. The question must be determined according to the facts in existence at the time of the sale."

An instructive case is that of Caledonia Mining Company v. Rowen,[10] wherein Acting Secretary Joslyn said:

"In regard to the burden of proof, it appears from the terms of Section 2342 that the Secretary of the Interior was authorized to designate and set apart such lands as were 'clearly agricultural,' which lands were thereupon to be open to entry as other public lands; wherefrom it is plain that Congress designed giving the right of homestead entry only in the event that the lands were clearly agricultural. After said designation they were *prima facie* of that character, and by existing rules the burden of proof falls upon the person traversing their *prima facie* character. In the case at bar the contestants' affidavit alleged that 'said land is essentially mineral land, and more valuable for mining than for agricultural purposes.' Your decision of June 10, 1882, very properly holds that 'it was not incumbent on the homesteader to show the agricultural capacity of the land,' for the reason that the presumptions were already in his favor; but it also declined a consideration of much testimony offered by the mineral claimants to show the non-agricultural character of the land, and therein it overlooked the fact that it was their plain duty to prove, first, that the land is not 'clearly agricultural;' second, that it is 'valuable for minerals;' and, third, that it is more 'valuable for mining than for agricultural purposes.' The case upon which your said action is based (North Leadville v. Searle, Sickels' Mining Laws, 349) is one in which the comparative value of the land was not involved; for, as remarked in a similar case (Townsite v. Placer, Copp's Mineral Land, 251), 'if the land is mineral, it was subject to location only under the provisions of the mining law, without reference to the relative value of a portion of the tract for townsite purposes.' But when the statutes provide for mineral entries upon land valuable for minerals, and for agricultural entries upon lands clearly agricultural, there arises of necessity a comparison of their respective values, whenever these two classes of claims come in conflict. And accordingly, July 10, 1872, in the case of the Central Pacific Railroad Company v. Mineral Affiants (Copp's Mining Decisions,

[9] Colorado Coal Co. v. U. S., 123 U. S. 307.
[10] Caledonia M. Co. v. Rowen, 2 L. D. 717.

128), Mr. Secretary Delano observed that 'the land is more valuable for agricultural than for mining purposes;' and to determine this relative value of mineral and agricultural lands has been a principal object of hearing since that date (Searl Placer Mine, 9 Copp's Land Owner, 189. and Maxwell v. Brierly, 10 ditto, 50); such, indeed, is the express direction of general circular of July 15, 1873, and substantially that of general circular of April 1, 1879. (Circular September 22, 1882, applies the rule to all cases, including townsites.) The burden of proof, then, being on the mineral claimant in this class of contests, it is competent for him to show his rights, not only absolutely, but relatively, by proof of the inferior rights of the agricultural claimant. And since it is a question in which the Government is interested, as well as the contestants, due weight should be given to all the facts in evidence. Consequently, when you declined to consider the testimony offered by the Caledonia Mining Company, to show the non-agricultural character and the relatively superior mineral character of the land in contest, and rested your decision solely on the testimony respecting its absolute mineral character, you ignored a portion of the evidence which is material to a just adjudication of the case."

It is not necessary that there should be upon the land a mine in working order from which gold is being actually produced; it is sufficient if it be shown by satisfactory proof that mineral exists in paying quantities, and such proof will usually be based on mining operations or explorations.[11]

In case of a contest between agricultural and mineral claimants, the burden of proof is not shifted to the mineral claimant by the non-mineral affidavit and publication of notice by the agricultural claimant.[12]

Contests may be initiated by an adverse party or *other person* against a party to any entry, filing, or other claim, under law of Congress relating to the public lands, for any sufficient cause affecting the legality or validity of the claim.[13]

A departmental decision that the land is mineral in character does not preclude subsequent investigation, on the part of the department, as to the character of such land, as the department retains jurisdiction to consider and determine the character of the land claimed under the mineral laws until deprived thereof by the issuance of a patent.[14]

If lands valuable for mineral are purchased as agricultural lands, with the knowledge that they are mineral lands, the patent issued by the Government would convey no title, because issued unadvisedly, or by mistake of an officer of the Government while acting ministerially. In such a case the parties purchasing the land are guilty of a fraud, and upon that ground a Court of equity will pronounce the patent void.[15]

It may be said, generally, that a land patent from the Government of the United States, issued with all the forms of law, may be shown to be void by any extrinsic evidence which is capable of showing a want of authority for the issue of the patent.[16]

[11] Johns v. Marsh, 15 L. D. 196.
[12] Mulligan v. Hansen, 10 L. D. 311.
[13] Rule 1, Rules of Practice in cases before the United States District Land Office and the General Land Office, and the Department of the Interior, approved August 13, 1885.
[14] Searle Placer, 11 L. D. 441.
[15] U. S. v. Culver, *supra*.
[16] Lakin v. Dolly, 253 F. R. 333; Francoeur v. Newhouse, 40 F. R. 618.

THE STATUTE OF LIMITATIONS.

Under the statute in regard to State or Territorial statute of limitations, the latter statute becomes the foundation upon which actively to assert a right, and is not limited as in other cases, to be used as a defense against an adversary's attack. The statute provides that where claims have been held and worked for a period equal to the term prescribed by the statute of limitations for mining claims for the State or Territory where the same is situated, evidence of such possession and working for such period shall be sufficient to establish a right to a patent thereto, under Chapter VI, Title XXXII of the Revised Statutes of the United States, in the absence of any adverse claim.[1]

It will thus be seen that the statute of limitations becomes a controlling factor as the basis of a claimant's right to a mining claim in contradistinction from its ordinary use as a shield for defense against an adverse claimant. In harmony with this view are the regulations of the General Land Office, that when an applicant bases his right to a patent upon the statute of limitations he is not required to file any evidence of location, copies of conveyances, or abstracts of title, as in other cases, but he is required to furnish a duly certified copy of the statute of limitations affecting mining claims in the State or Territory within which the mine is situated, together with his sworn statement giving a clear and succinct narration of the facts as to the origin of his title, and likewise as to the continuation of his possession of the mining ground covered by his application; the area of his claim, the nature and extent of the mining that has been done thereon; whether there has been any opposition to his possession, or litigation with regard to his claim, and if so, when the same ceased; whether such cession was caused by compromise or by judicial decree; and any additional facts within the claimant's knowledge, having a direct bearing upon his possession and *bona fides* which he may desire to submit in support of his claim. Thereafter, the proceedings are the same as in other cases, excepting that the statement of facts as to the origin of the title of the applicant must be corroborated by the affidavit of one or more disinterested witnesses.

EASEMENTS.

The statute of Congress made the subjects of working mines involving easements, drainage, and other means to their complete development, a matter of State or Territorial legislation.

In 1891, the Legislature of California passed an Act relating to those subjects. In Section 2 of this Act it is provided that "all mining locations and mining claims shall be subject to a reservation of the right of way through or over any mining claims, ditches, roads, canals, cuts, tunnels, and other easements, for the purpose of working other mines; provided, that any damage occasioned thereby shall be assessed and paid for in the manner provided by law for land taken for public use under the right of eminent domain."[2]

It is believed that the Supreme Court of this State will follow its decisions in former cases, and hold that this section is unconstitutional

[1] U. S. R. S., Sec. 2332; Mining Co. v. Bullion, 9 Nev. 240.
[2] Cal. Stats. 1891, p. 219.

as to any retroactive force. There are decisions in other States to the contrary, and our Supreme Court may follow them, if the question is again brought before it. In all locations made prior to March 31, 1891 (the date of the approval of said Act, which by its terms took effect immediately), there can be no question that under our Supreme Court decisions, as they exist up to date, this section of the Act is a nullity. We are not prepared to say just what effect the quoted section of the Act may have upon mining locations made after the date of its approval. But it clearly seems that the Mining Act of Congress and said section should be construed together, having in view the paramount or controlling power of the Federal statute. This gives the State the power to make a law regulating the matters touched on in said section. Unquestionably, as every one is presumed to know the law, every person locating a mining claim subsequently to March 31, 1891, locates with a knowledge of the provisions of such section, which virtually becomes a portion of his notice; consequently, why is it not constitutional as to such location? A party takes certain property with the knowledge that others may acquire certain rights therein for certain purposes upon compensation made or tendered. He, therefore, is not prejudiced by the provisions of the law. No law is retroactive unless made so in terms. This is not done in the Act referred to, and claims located before its enactment would seem not to be subject to its provisions.

WATER RIGHTS.

The first legislation on this subject is contained in the Act of 1866, which has been, with only verbal changes, incorporated into the Revised Statutes of the United States.[1] Section 9 of this Act confirms all rights to the use of water which have accrued by priority of possession, not only for mining purposes, but for agricultural, manufacturing, and other purposes as well. Its provisions were based upon, and were intended to adopt, the customs and rules in regard to water rights as they existed in California up to the time of the passage of the Act, as they had been construed by the Courts of that State. Such customs and rules were based upon the wants of the community and the peculiar condition of things in that State, for which there existed no precedent.

In the legislation Congress enacted it simply made valid or legal rights that theretofore had existed rather through silent acquiescence than by the positive recognition of the Federal Government. Whenever rights to the use of water by priority of possession have become vested, and are recognized by the local customs, laws, and decisions of the Courts, the owners and possessors are protected in them; and the rights of way for ditches and canals incident to such rights, being recognized in the same manner, are acknowledged and confirmed.[2] The laws of California provide fully the steps to be taken in acquiring water rights and how such rights may be lost.[3] A person desiring to appropriate water in this State must post a notice in writing, in a conspicuous place, at the point of intended diversion, stating therein:

(1) That he claims the water there flowing to the extent of (giving the number) inches, measured under a 4-inch pressure.

[1] Jennison v. Kirk, 98 U. S. 453.
[2] Jennison v. Kirk, *supra*.
[3] C. C. C., Sec. 1410, *et seq.*

(2) The purposes for which he claims it (which must be a useful or beneficial purpose), and the place of intended use.

(3) The means by which he intends to divert it, and the size of the flume, ditch, pipe, or aqueduct in which he intends to divert it.

A copy of the notice must, within ten days after it is posted, be recorded in the office of the Recorder of the county in which it is posted. Within sixty days after the notice is posted the claimant must commence the excavation or continuation of the works in which he intends to divert the water, and must prosecute the work diligently and uninterruptedly to completion, unless temporarily interrupted by snow or rain. By completion is meant conducting the waters to the place of intended use. A failure to comply with such rules deprives the claimant of the right to use the water as against a subsequent claimant who complies therewith. Notice alone of an intent to divert water of a stream for a specific purpose will not of itself constitute an appropriation, but it must be followed by the commencement and completion of the works for the diversion thereof.[4]

A person entitled to divert a given quantity of water from a stream may take it at any point on the stream, and may change the point of diversion at pleasure, if the rights of others be not attacked injuriously.[5] The right to take water having been once acquired, the manner and place of taking it cannot be questioned by those not injured thereby,[6] and the ditch, flume, pipe, or aqueduct by which the diversion is made may be extended to places beyond that where the first use was made.[7] There seems to be no limit to the amount of water that may be appropriated by the first claimant.[8] The rights of riparian proprietors are not affected by the above provision.[9] In a late case in California, the subject of riparian rights received an elaborate and exhaustive consideration, to which case the reader is referred to the questions therein involved.[10] On the filing of a homestead entry upon public land, for which a patent is subsequently issued, rights in a stream flowing over the land become vested in the homestead settler, and the waters thereof are no longer subject to the right of appropriation.[11]

MINING PARTNERSHIPS.

Mining partnerships are distinct associations, with different rights and liabilities attaching to their members from those attaching to members of ordinary trading partnerships. They exist in all mining communities; indeed, without them successful mining would be attended with difficulties and embarassments much greater than at present.[1]

A mining partnership exists in California when two or more persons, who own or acquire a mining claim for the purpose of working it and extracting any mineral therefrom, are actually engaged in working the same.[2] Being actually engaged in working the mine is essential to the

[4] Thompson v. Lee, 8 Cal. 275.
[5] C. C. C., Sec. 1412.
[6] Kidd v. Laird, 15 Cal. 161; Sieber v. Frink, 2 W. C. R. 98.
[7] C. C. C., Sec. 1412.
[8] See 2 W. C. R. 300.
[9] C. C. C., Sec. 1422.
[10] Lux v. Haggin, 69 Cal. 255.
[11] Sturr v. Beck, 6 Dak. 71.

[1] Kahn v. Smelting Co., 102 U. S. 64; Bissell v. Foss, 114 U. S. 252.
[2] C. C. C., Sec. 2511.

formation of the partnership, otherwise the owners of the mine are simply tenants in common,[3] and the relation arises from the ownership of shares, or interests in the mine, and working the same for the purpose of extracting the mineral therefrom.[4] The essential difference generally existing between ordinary copartnerships and mining partnerships is that in the latter a partner has no right to decide what new partners, if any, shall be admitted to the firm, and no dissolution results from the death of a partner.[5] So one of the partners in a mining partnership may convey his interest in the mine and business without dissolving the partnership. The purchaser from the date of his purchase becomes a member of the partnership, and takes it subject to the liens existing in favor of the partners, for debts due all creditors thereof, or advances made for the benefit of the partnership, unless he purchased in good faith, for a valuable consideration, without notice of such lien. The purchaser when the partnership is engaged in working the mine takes with notice of all liens resulting from the relation of partners to each other and to the creditors of the new partnership;[6] that is, in other words, new partners are liable for old debts.[7] The mining ground owned and worked by partners in mining, whether purchased with partnership funds or not, is partnership property.[8] The profits and losses of a mining partnership are shared proportionately to the respective interests, or shares, held by each member thereof;[9] and no contract in writing binds the partnership, except by express authority derived from the members thereof;[10] and the affairs of the partnership are conducted according to the policy dictated by the owners of a majority of its shares.[11] An agreement to excavate two tunnels in consideration of all ores found therein, and an undivided half of certain lodes, does not constitute a partnership.[12] Where the parties make an agreement that one of them shall prospect for mines and the other shall furnish the money and supplies, the interests in the mining ground discovered to be shared between them, this constitutes a prospecting partnership,[13] and makes the partners co-tenants in such ground. An agreement to work a mine for the owner on shares creates a mining partnership.[14]

MINER'S LIENS.

A claim of lien for labor performed on a mining claim, which states the kind or number of days of labor, with the dates between which it was performed, the price agreed to be paid therefor per day, and the aggregate amount due, and that "the terms of payment for said labor were cash as soon as said labor was performed," sufficiently shows the terms, time given, and condition of the contract.[1] Whilst the statute giving liens to mechanics and laborers for their work and labor is to be

[3] Dougherty v. Creary, 30 Cal. 290.
[4] C. C. C., Sec. 2511.
[5] Jones v. Clark, 42 Cal. 481.
[6] C. C. C., Secs. 2516, 2517.
[7] Jones v. Clark, *supra*.
[8] C. C. C., Sec. 2515.
[9] C. C. C., Sec. 2513.
[10] C. C. C., Sec. 2519.
[11] C. C. C., Sec. 2520.
[12] Barber v. Gonzales, 30 Cal. 93.
[13] Boucher v. Mulverhill, 1 Mont. 306; Miller v. Butterfield, 79 Cal. 62.
[14] Settembre v. Putnam, 30 Cal. 490.
[1] Tredwinick v. Mining Co., 72 Cal. 79.

liberally construed, so as to afford the security intended, it cannot be too strongly impressed upon them that they must not only bring themselves, by their notice, clearly within the provisions of the statute, but they must be prepared, if the priority of their lien be disputed, to show a compliance with those provisions, and to fix with certainty the commencement and completion of their work.[2] For the purposes of a lien, work done on tools and machinery connected with the mine is work done on the mine.[3] But a lien is not given for hauling ore from the mine to the mill.[4] Work done on a mine and a mill, which lie some distance apart, is work done on two separate pieces of property, though performed under one contract.[5]

TOWNSITES.

The United States laws limit the quantity that shall be included in the patent of a townsite to the number of its inhabitants. Where there are over one hundred and less than two hundred inhabitants, the patent can only embrace lands not exceeding 320 acres; where the inhabitants number more than two hundred and less than one thousand, it cannot embrace more than 640 acres; and where the inhabitants are one thousand or more it cannot exceed 1,280 acres. For each additional one thousand inhabitants, not exceeding five thousand, a further grant of only 320 acres is allowed. Land embraced within a townsite on the public domain, when unoccupied, is not exempt from location and sale for mining purposes; its exemption is only from settlement and sale under the preëmption laws of the United States. Some of the most valuable mines in the country are within the limits of incorporated cities, which have grown up on what was, on its first settlement, part of the public domain, and many of such mines were located and patented after a regular municipal government had been established. Such is the case with some of the famous mines of Virginia City, in Nevada. Indeed, the discovery of a rich mine in any quarter is usually followed by a large settlement in its immediate neighborhood, and the consequent organization of some form of local government for the protection of its members. Exploration in the vicinity for other mines is pushed in such case by newcomers with vigor, and is often rewarded with the discovery of valuable claims. To such claims, though within the limits of what may be termed the site of the settlement or new town, the miner acquires as good a right as though his discovery was in a wilderness, removed from all settlement, and he is equally entitled to a patent for them.

The Acts of Congress relating to townsites recognize the possession of mining claims within their limits, and forbid the acquisition of any mine of gold, silver, cinnabar, or copper within them, under proceedings by which title to other lands there situated is secured, thus leaving the mineral deposits within townsites open to exploration and the land in which they are found to occupation and purchase, in the same manner as such deposits are elsewhere explored and possessed, and the lands containing them acquired.

[2] Davis v. Alford, 94 U. S. 545.
[3] Melone v. Big Flat Co., 76 Cal. 578.
[4] Barnard v. McKenzie, 4 Colo. 251.
[5] Davis v. Alford, *supra*.

Whenever, therefore, mines are found in lands belonging to the United States, whether within or without townsites, they may be claimed and worked; provided, existing rights of others from prior occupation are not interfered with.[1] This language is only applicable to unoccupied public lands in unpatented townsites, and to mines in patented townsites outside of the limits of the patent.[2] And an attempted location of a mining claim upon a lot, the title to which has passed into private ownership by patent from the United States, would be invalid.[3]

It would seem that there may be an entry of a townsite, even though within its limits mineral lands are found, the entry and the patent being inoperative as to all lands known at the time to be valuable for their minerals, or discovered to be such before their occupation and improvement for residences or business under the townsite title.[4]

Townsite lots located upon an abandoned mining claim are not a location upon lands "known to be valuable for its minerals"; to be within such terms they must not only be known, but known to be valuable at the date of the patent, or discovered to be so before occupation or improvement, and it cannot be presumed that, because the ledge was once profitably worked before the townsite patent, it must be deemed to have continued valuable at the date of the patent, if work on the ledge was abandoned before the date of the patent.[5]

In regard to coal, iron, and tin mining as specific branches of the American mining industry, it is sufficient to say that their consideration does not fall within the scope of this article.

In the foregoing presentation of the views expressed, the writer is far from claiming immunity from error or completeness of exposition. He has placed limits upon the number of mining decisions cited, and endeavored to cite out of the multitude such only as seemed the most apposite and that most directly expressed the established law. Experience in mining litigation has enforced upon him the consciousness of liability to mistake, and that forecast can never equal the result of past experience. He has sought to present such an epitome (and it assumes to be nothing more) of American mining law as will be of practical benefit to those engaged in mining pursuits; that great branch of industry, beneficial though it is, and often lucrative, is likewise attended with hardships and disappointments, grievous to bear. Should the foregoing be of service to those whose labors should be attended with all the security that the law can give, its purpose will be fulfilled.

[1] Steel v. Smelting Co., 106 U. S. 447; U. S. R. S., Sec. 2380, *et seq.*
[2] Davis v. Wiebold, 139 U. S. 507.
[3] McCormick v. Sutton, 97 Cal. 373.
[4] Deffeback v. Hawke, 115 U. S. 392.
[5] Richards v. Dower, 81 Cal. 44.

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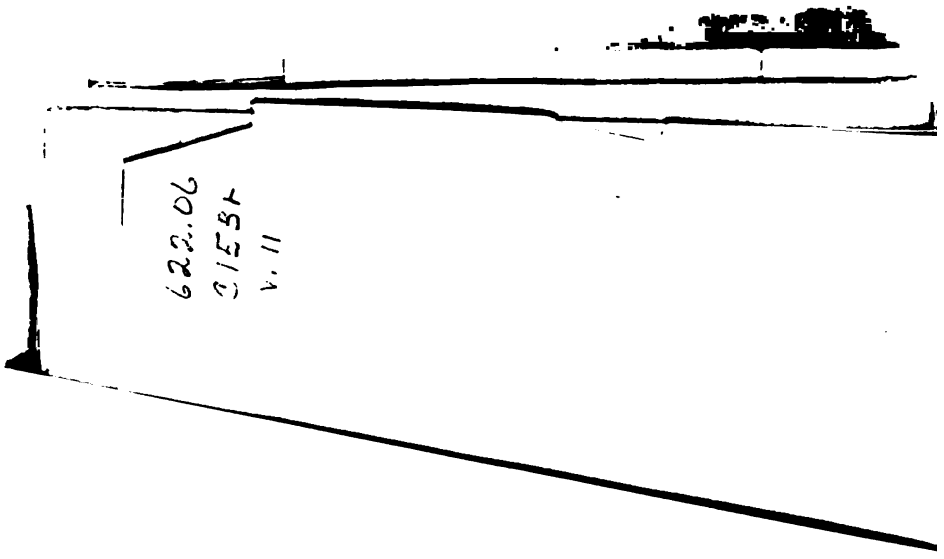
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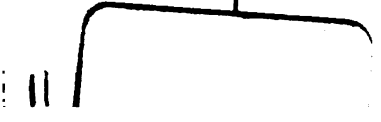
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